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REPORT

TO

ALBERTA ENVIRONMENT

ON

HYDROGEOLOGICAL ASSESSMENT OF THE PROPOSED PINE COULEE RESERVOIR

OUR FILE: A85-2097

OCTOBER, 1985

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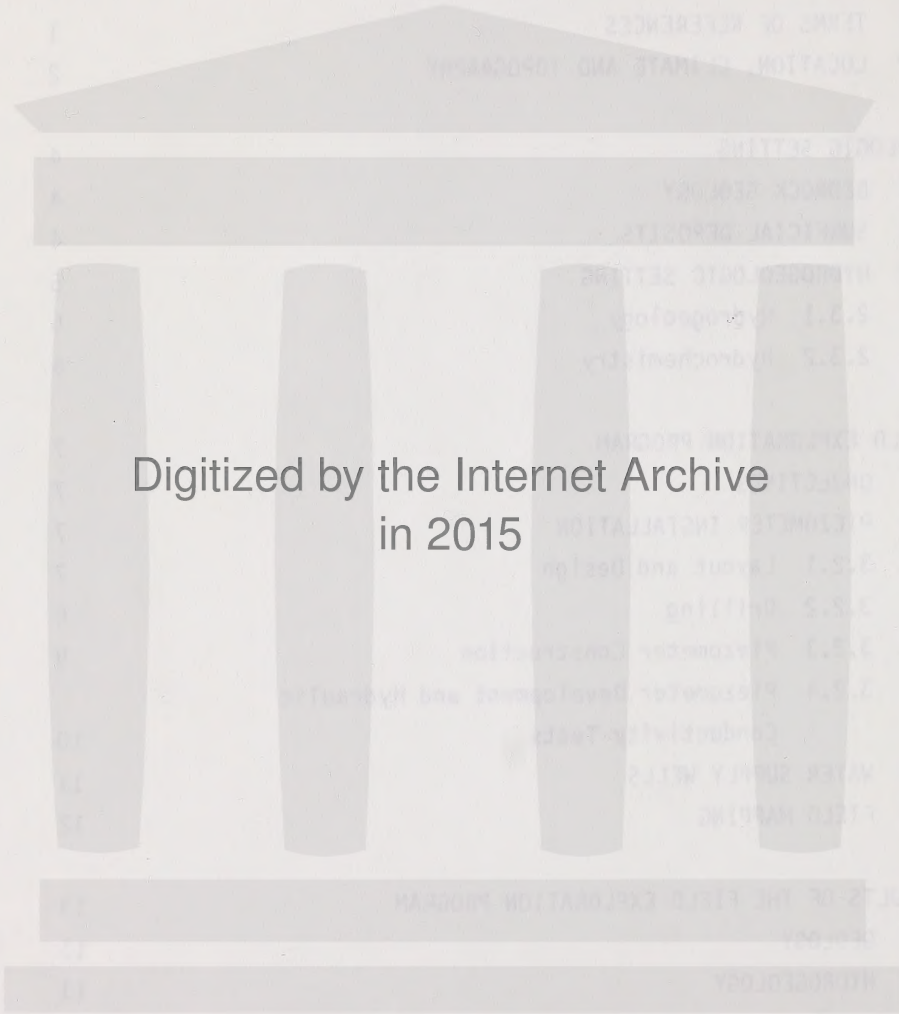

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1. INTRODUCTION

1.1 TERMS OF REFERENCE

Alberta Environment (Planning Division) is reviewing the feasibility of an earthfill dam in the Pine Coulee. The purpose of this dam would be to provide off-stream water storage in the Willow Creek drainage basin. Water for storage would be diverted from Willow Creek by both natural drainage courses and an excavated channel. The resulting Pine Coulee reservoir would have a maximum depth, at the dam, of approximately 21 m.

Piteau Engineering has been retained to assess the hydrogeological conditions in the reservoir area. In particular, the purpose of the study, as outlined in our proposal dated July 19, 1985, is to:

1. Establish a groundwater monitoring system around the proposed reservoir.

2. Assess potential water losses from the reservoir into the surrounding geological formations.

3. Predict the distance at which groundwater surface elevations will be affected by reservoir impoundment.

4. Delineate areas where local flooding may occur as a result of rising groundwater surface elevations.

This report describes the work and testing performed by Piteau Engineering Ltd. The field program was conducted from August 8 - 30, 1985, inclusive. Drilling was performed by Allkind Drilling Ltd. and the site survey was carried out by D.A. Watt Consulting Group Ltd.

Piteau Engineering Ltd. acknowledges the help of Messrs. Don Prosser, John Campbell and Dan Hubbard of Alberta Environment on this project.

1.2 LOCATION, CLIMATE AND TOPOGRAPHY

The proposed location of the Pine Coulee dam is 600 m upstream of the junction of the Pine and Willow Creeks, in S.W. 34, TWP 13, RGE 28, W4M. The reservoir would extend north for approximately 12.8 km into SEC 3, TWP 15, RGE 28, W4M (Figure 1). The damsite and reservoir are situated about 6 km due west of the town of Stavely.

The mean January, July and annual temperatures at Gleichen, to the north, are -12.2°C, 17.9°C and 3.5°C, respectively. The mean January, July and annual temperatures at Vauxhall, to the east, are -10.7°C, 18.9°C and 4.3°C, respectively (Canada Department of Transport, Meteorological Branch, 1967). The mean annual precipitation is 419 mm and the annual potential evapotranspiration is approximately 762 mm near Claresholm (Ozoray and Lytviak, 1974). Hence, the potential evapotranspiration is approximately 1.8 times the precipitation.

The dam and reservoir lie on the western edge of the Interior Plains physiographic region, near the Porcupine Hills. Surface water, aided by low infiltration rates, runs eastward from these hills towards the Willow Creek and Pine Coulee area. Local relief is subdued, with the exception of the north-trending Pine and Willow Creek valleys, which are

incised some 25 - 35 m into the uplands above the valleys. Both the Pine and Willow Creeks belong to the Oldman Drainage Basin.

Shallow sloughs and lakes are common in this area and are subject to high seasonal fluctuations both in water surface elevations and areal extent. They are occasionally brackish and frequently have salt-crusted shorelines.

2. GEOLOGIC SETTING

2.1 BEDROCK GEOLOGY

Bedrock in the reservior area belongs primarily to the Lower Tertiary Porcupine Hills Formation, which consists of pale grey, calcareous sandstone interbedded with pale grey calcareous mudstone. This is underlain by the Lower Tertiary/Upper Cretaceous Willow Creek Formation, which consists of interbedded grey calcareous sandstone and bentonite mudstone, with occasional thin beds of limestone. The remaining thickness of the Porcupine Hills Formation varies from approximately 200 m to the west of the reservoir to 0 m a few kilometres to the east, where the Willow Creek Formation forms the bedrock surface. The Willow Creek Formation also varies in thickness from east to west, but is approximately 500 m underneath the Pine Coulee (Ozoray and Lytviak, 1974).

The depth of the bedrock surface in the reservoir area is shallow. Bedrock topography can vary from actual outcrops to depths of 20 - 30 m over a distance of a few hundred metres. The bedrock is intermittently exposed on the uplands and in river valley slopes that have been eroded. Outcroppings are more numerous to the west, and 5 - 6 km away, the bedrock rises to form the topographically diverse Porcupine Hills.

2.2 SURFICIAL DEPOSITS

In the bottom of Pine Coulee, surficial deposits are represented by approximately 10 m or more of clay with interbedded sand, silt and occasional gravel (Figure 2). These sediments are of glaciofluvial or post-glacial alluvial origin (Alberta Environment Memorandum, June 4, 1984). Colluvium on the valley slopes was derived mostly from glacial or alluvial material.

On the uplands surrounding the Pine Coulee, clayey or silty till is present and may exceed 30 m in thickness (Figure 2). Occasional lenses of silt and sand are present within the till. According to Alberta Environment (Memorandum, dated June 4, 1984), the till to the west of the valley was extensively modified by glacial meltwater, in some places being completely eroded and leaving boulders on the surface. Meltwater channels were incised through the glacial deposits, into bedrock, and subsequently infilled with glaciofluvial materials such as clays, silts and sands. The granular deposits in the gravel pit located in SWS, TWP 14, RGE 28, W4M are likely derived from these glaciofluvial materials.

Towards the south end of the reservoir, approximately 400 m northeast of the dam centreline, the Stavely Buried Channel trends from west to east (Figure 2). This channel is infilled with preglacial sands and gravels up to 6 m thick and is now buried by approximately 15 m of alluvial or glacial deposits. According to Geiger (1968), the Stavely Buried Channel was part of the Lethbridge Valley system, which provided drainage in southern Alberta during preglacial time. A tributary of this channel also coincided with the present course of the Pine Coulee (Geiger, 1968).

2.3 HYDROGEOLOGIC SETTING

2.3.1 Hydrogeology

The regional groundwater flow in the Pine Coulee area is towards the east. Locally, the Pine Coulee acts as a drainage area intercepting surface water and shallow groundwater flow.

The term hydrostratigraphic unit describes water-bearing zones of similar groundwater recharge circulation and hydrochemical

conditions. A lower (bedrock) hydrostratigraphic unit is represented by the Porcupine Hills Formation. The various surficial fine-grained deposits of glacial and/or alluvial origin form an upper hydrostratigraphic unit. This unit contains various higher hydraulic conductivity lenses of silt and/or sand. Drilling records obtained from Alberta Environment indicate that these lenses are generally near-surface and discontinuous.

The hydraulic conductivities of these units have been determined by Alberta Environment (1985) to be low, with values commonly less than 1×10^{-7} m/s indicating slow groundwater movement. Ozoray and Lytviak (1984) have estimated the 20-year safe yields of these units to be no greater than 1.67 l/s for the Porcupine Hills Formation and no greater than 0.42 l/s for the surficial materials. Neither unit is considered an important regional water source.

A third hydrostratigraphic unit on site is represented by the preglacial sands and gravels of the Stavely Buried Channel. The exact nature and extent of this deposit is unknown, but 20-year safe yields may be as high as 7.50 l/s (Ozoray and Lytviak, 1984).

2.3.2 Hydrochemistry

Groundwater in the region commonly ranges between 500 and 1000 mg/l in total dissolved solids (TDS). This range of values is typical of groundwater in southern Alberta. Waterwell records in the Pine Coulee area indicate that the groundwater is a soft, sodium-bicarbonate type. This typifies a mature water where natural softening has occurred with age and sodium has replaced calcium in a cation exchange process. The chloride content, in milliequivalents, is usually less than 10%.

3. FIELD EXPLORATION PROGRAM

3.1 OBJECTIVES

The primary objectives of the field exploration program were to define groundwater surface elevations in the reservoir area and to determine the hydraulic conductivities of the local geologic units. With this information, a qualitative and quantitative evaluation of the integrity of the proposed reservoir could be made.

3.2 PIEZOMETER INSTALLATION

3.2.1 Layout and Design

Sixteen piezometer nests (A - Q, excluding E), totalling 32 piezometers, were constructed on site (Figure 3). A piezometer was not installed in Hole E because drilling penetration was minimal. Each nest was denoted with a letter, rather than a number, to avoid confusion with holes drilled during previous studies by Alberta Environment and PFRA. Eleven nests were located around the perimeter of the reservoir and five nests were located in the Pine Coulee. Of the latter five nests, four (A, B, C and D) were drilled at the south end of the reservoir to delineate the Stavely Buried Channel. The remaining nest (Q) was drilled to locate the groundwater surface and further define the geology at the north end of the reservoir. No drillholes were located on the slopes of the Pine Coulee, due to difficulty in accessing these areas with a drill rig. A backhoe would be ideally suited for test pitting on the slopes and should be considered in future hydrogeological investigations. Survey coordinates for each piezometer are given in Appendix I.

An upper and lower piezometer was usually installed at each site in order to determine groundwater surface elevations and vertical hydraulic gradients. However, in two nests (A and J), 3 piezometers were installed and in a further two nests (F and P), only 1 piezometer was installed. This was in response to local hydrogeologic conditions. In order to assure hydraulic isolation, individual piezometers were installed in separate drillholes.

3.2.2 Drilling

Drilling was carried out using a B-61 truck-mounted continuous flight auger rig. The rig was supplied and operated by Allkind Drilling Ltd. of Calgary. This type of rig accommodated drilling in fine-grained, unconsolidated formations. Also, as no drilling fluids were used, the possibility of introducing contaminants was minimized.

Both the hollow stem auger (HSA) and the solid stem auger (SSA) were used for drilling due to difficult conditions encountered. The HSA was used in the Pine Coulee where caving of the drillholes was a problem and the SSA was used for shallow holes, where caving was not a problem. The SSA was also used for deeper holes on the uplands, where the HSA could not effectively penetrate gravelly (till) deposits. Since the SSA had to be removed from the hole prior to installation of a piezometer, leaving an open hole prone to caving, the maximum depth of installation was therefore limited.

Samples were usually taken every 1.5 or 3 m during drilling and were classified according to the Modified Unified System Classification of Soils for Engineering Purposes (Modified USC).

When drilling with the hollow stem auger, samples were obtained through the drill stem by removing the bit and inserting a Shelby or a splitspoon tube. Samples recovered this way were relatively undisturbed. When drilling with the solid stem auger, samples were obtained by withdrawing the entire drill string and examining the material on the bit. Samples recovered this way were relatively disturbed. The borehole logs are presented in Appendix II.

3.2.3 Piezometer Construction

The piezometers were either installed through the hollow stem auger or, if the hole was drilled with the solid stem, in the hole after the drill string was withdrawn. A piezometer tip consisting of 51 mm of machine slotted, schedule 40 PVC pipe (3 rows, 0.020 inch) was placed in the drillhole. The annulus around the piezometer screen was then packed with a graded (12/20) Frac sand. A bentonite seal was placed above the sand pack to prevent leakage from above the hole and the remaining annulus to near ground level was infilled with drill cuttings mixed with bentonite pellets. When the piezometer tip was completed in a zone above the bottom of the hole, a bentonite seal was first placed below the tip to assure hydraulic isolation.

A 1.5 m long, 152 mm diameter protective steel casing was inserted at the surface to protect each piezometer from damage. This casing was complete with a locking steep cap. A cement plug was also placed around the casing to prevent inflow of surface runoff. These casings were frequently located (by necessity) in

the ditches next to roadways and should therefore be periodically inspected for damage and the cement plug maintained. Piezometer construction details are given in Appendix II.

3.2.4 Piezometer Development and Hydraulic Conductivity Tests

All piezometers containing water were developed by flushing out the water column. This was usually performed by nitrogen purging. Either 6 mm plastic tubing or 19 mm PVC pipe, depending on the development required, was placed at selected depths below the water level and nitrogen applied under pressure. In this way, silty and/or clayey material was drawn into the piezometer and then discharged with the water. In piezometers with insufficient water to purge, development was carried out by bailing. Bailing provides a surging action which results in the removal of fine material.

Hydraulic conductivity tests were performed on all functioning piezometers and the data was reduced using the standard method of Hvorslev (1951). Generally, falling head tests were used in piezometers above the groundwater surface and rising head tests were used in piezometers below the groundwater surface. In these tests, water is either poured into or bailed out of the piezometer and the water level rise or fall is measured with time.

The data from a hydraulic conductivity test is representative of only the zone in the immediate vicinity of the piezometer because a relatively small volume of water is removed or added. Also, this zone may be disturbed by drilling and installation

procedures. Small variations in clay content can greatly change the K value of otherwise permeable geologic deposits. Therefore, values of K from this type of test are only approximate.

The water for falling head tests was acquired from local sources, such as the town of Claresholm, Willow Creek and farmer's wells. This method is not ideal as the chemical nature of the water in the piezometer may be altered. However, because those piezometers in which falling head tests were performed were usually dry, they would likely not be sampled in a hydrochemical program. The hydraulic conductivity tests and calculations are given in Appendix III.

3.3 WATER SUPPLY WELLS

A survey of local water supply wells was also undertaken (Figure 3). The well logs are presented in Appendix IV. Frequently, each farm had two wells, one for domestic use and one for agricultural purposes. The wells were usually completed in bedrock, at a depth varying from less than 30 m to greater than 60 m. Yields from these wells rarely exceed 1.67 l/s and are commonly less than 1.25 l/s.

Interviews with the farmers in the area revealed that in recent years, water levels have declined substantially and many new wells have had to be drilled. This is probably in response to three years of consecutive drought and therefore, reduced groundwater recharge.

3.4 FIELD MAPPING

Hydrogeologic field mapping of the Pine Coulee and surrounding area was performed during and after the drilling program.

In the Pine Coulee, at the north end of the reservoir, groundwater is at the ground surface, while near the dam location, groundwater was 5 - 6 m below surface. Two springs were also mapped at the north end of the Pine Coulee on the east bank (Figure 3).

Surface water was restricted to shallow lakes and sloughs on the uplands. Several of these have been completely evaporated or drained as a result of reduced precipitation in recent years. For example, the large lake in SEC 25 and 36, TWP 13, RGE 28, W4M has been completely drained for agricultural purposes.

Many of the existing dugouts, which provide water for cattle, on the uplands were dry and new, deeper dugouts were being constructed. These dugouts are above the groundwater surface and rely on rainfall which is then retained by the relatively impervious underlying till. Dugouts in the Pine Coulee were below the groundwater surface and contained water.

Bedrock outcrops were usually limited to elevations above the proposed reservoir full supply level (F.S.L.), with the exception of small exposure in creek beds on the banks of the Pine Coulee. These outcrops typically consist of sandstone and shale, with shale being preferentially removed by weathering.

Much of the upland ground surface was covered with boulders which were derived from eroded till moraine. These boulders were sub-rounded, up to 30 cm in diameter, and of a varied genesis.

4. RESULTS OF THE FIELD EXPLORATION PROGRAM

4.1 GEOLOGY

The stratigraphic units encountered during the drilling program were consistent with those described in the literature. Bedrock (P-P1 and M-P1) underlying the study area was either sandstone or shale (mudstone), typical of the Porcupine Hills Formation.

Quaternary deposits (e.g., O-P1 and H-P1) on the uplands consisted of 0, to greater than 30 m of silty clay with sub-rounded boulders and occasional, near surface gravel, sand or silt layers. This sequence is likely a till moraine that has been altered by erosional processes at the top (Figure 4). Quaternary deposits in the Pine Coulee (e.g., A-P2 and B-P2) consisted of 9 m or more of silty clay with occasional, discontinuous sand and/or silt lenses throughout. This sequence is likely a glacialfluvial or alluvial deposit (Figure 4).

In the Pine Coulee, an east-west band of sand and gravel, more than 10 m thick in places, (A-P1 and B-P1) was encountered. This band is approximately 400 m wide and covered by 13 - 16 m of silty clay. A water well (Figure 3, Well #1) some 325 m east of piezometer B-P1 was previously completed in 6.5 m of the sand and gravel above the bedrock. This deposit is likely the preglacial sand and gravel of the Stavely Buried Channel.

4.2 HYDROGEOLOGY

The results from hydraulic conductivity tests are listed in Table 1. These results indicate that the silty clay, of glacial or alluvial

TABLE 1.

HYDRAULIC CONDUCTIVITIES

PIEZOMETER	COMPLETION ZONE	MATERIAL PIEZOMETER COMPLETED IN	HYDRAULIC CONDUCTIVITY (m/s)	TEST USED
A-P1	17.53 - 20.57	Clayey Gravel	5.0×10^{-7}	Bail
A-P2	13.56 - 15.09	Silty Clay with Sand Lenses	4.2×10^{-6}	Bail
A-P3	5.79 - 6.71	Silty Clay with Silt Lenses	1.3×10^{-6}	Bail
B-P1	14.33 - 17.37	Clayey Gravel and Sand	4.9×10^{-6}	Bail
B-P2	4.57 - 7.62	Silty Clay	1.9×10^{-9}	Bail
C-P1	10.52 - 12.04	Silty Clay	piezometer not functioning	Piezometer not functioning
C-P2	3.96 - 5.49	Silty Clay with Sand Lenses	6.6×10^{-9}	Slug
D-P1	10.21 - 11.73	Sandstone	6.7×10^{-8}	Bail
D-P2	5.79 - 7.32	Silty Clay	7.5×10^{-7}	Bail
F-P1	5.18 - 6.71	Clayey Silt	1.9×10^{-8}	Bail
G-P1	6.10 - 7.62	Clayey Silt	9.6×10^{-9}	Slug
G-P2	26.97 - 30.02	Silty Clay	3.4×10^{-7}	Bail
H-P1	10.36 - 13.41	Silty Clay with Sand Laminae	1.9×10^{-8}	Bail
H-P2	2.44 - 3.96	Silty Sand	3.1×10^{-8}	Slug
I-P1	7.01 - 8.53	Clayey Silt with Sandstone Layers	1.6×10^{-7}	Slug
I-P2	2.90 - 4.42	Clayey Silt	3.3×10^{-8}	Slug
J-P1	5.49 - 7.01	Silty Clay with Fe-Stained Joints	6.6×10^{-9}	Bail
J-P2	2.74 - 4.27	Silty Clay	9.0×10^{-8}	Slug
J-P3	18.29 - 21.34	Silty Clay	1.4×10^{-9}	Bail
K-P1	3.05 - 4.57	Clayey Silt	8.3×10^{-9}	Slug
K-P2	13.11 - 14.63	Silty Clay	3.4×10^{-9}	Slug
L-P1	13.41 - 14.94	Silty Clay	6.6×10^{-10}	Slug
L-P2	3.05 - 4.57	Silty Clay	5.2×10^{-8}	Slug
M-P1	12.04 - 12.65	Shale	1.1×10^{-9}	Slug
M-P2	3.05 - 4.57	Silty Clay and Shale	8.0×10^{-9}	Slug
N-P1	9.75 - 14.33	Silty Clay and Shale	7.4×10^{-10}	Bail
N-P2	2.74 - 3.66	Clayey Gravel	2.0×10^{-6}	Slug
O-P1	13.11 - 14.63	Silty Clay	1.1×10^{-8}	Bail
O-P2	2.74 - 3.66	Clayey Gravel	3.3×10^{-6}	Slug
P-P1	14.78 - 17.83	Silty Clay	8.9×10^{-9}	Slug
Q-P1	1.37 - 2.29	Silty Clay	9.6×10^{-10}	Slug
Q-P2	6.71 - 8.23	Silty Clay with Silt Laminae	1.0×10^{-5}	Bail

origin, which overlies the site, has a low hydraulic conductivity (K) ranging from 7.5×10^{-7} m/s (D-P2) to 6.6×10^{-10} m/s (L-P1). Contained within the silty clay are occasional silt, sand and gravel lenses of intermediate K, ranging from 1.0×10^{-5} (Q-P2) to 4.2×10^{-6} m/s (A-P2). Drilling from this study, and previous drilling by Alberta Environment, indicates that these lenses are either discontinuous or near-surface and are likely of limited hydrogeological importance.

The Stavely Buried Channel was tested twice for hydraulic conductivity and has intermediate values of 4.9×10^{-6} (B-P1) to 5.0×10^{-7} (A-P1). These tests represent a small portion of this aquifer. Interviews with the owner of Well #1, which was completed in the Stavely Buried Channel, revealed that the well was tested at over 2.65 l/s when completed. Bedrock (sandstone and shale) was also tested twice for hydraulic conductivity and has low values of 6.7×10^{-8} (D-P1) to 1.1×10^{-9} (M-P1). These measurements are representative of only the top 1 m or so of bedrock. They are in rough agreement with hydraulic conductivity tests performed by Alberta Environment (Memorandum, June 12, 1985) on two previous boreholes in bedrock. However, further limited testing is advisable in order to more completely sample bedrock throughout the reservoir area.

Both the bedrock and the Stavely Buried Channel would probably be hydraulically separated from th reservoir by the overlying silty clay. However, if a hydrogeological window opened between the reservoir and the Stavely Channel, the latter may have the potential to act as a drain. Therefore, it is advisable that a more representative test, such as an aquifer test, be conducted to determine the hydraulic properties of the channel.

Groundwater surface elevations were measured in late August, 1985 (Figure 4) and are related to the bedrock topography. Groundwater surface elevations near topographic highs, such as bedrock outcrop on the west side, are usually the greatest (Figure 5). These measurements indicate that the groundwater surface was 1085.31 m at N-P1 to the west of Pine Coulee. To the east, the groundwater surface was 1048.51 m at O-P1. However, the elevations measured during the field program are likely lower than normal due to three factors:

1. The measurements were taken during the period of low seasonal groundwater surface elevations;
2. The measurements were taken after 3 years of drought; and,
3. Many piezometers were completed in very low K material and require extended periods of time to stabilize.

Groundwater surface elevations in the Stavely Buried Channel indicate that it is a confined aquifer with an excess head of 7.5 - 12 m. Flowing or artesian conditions were not encountered in Piteau drillholes that intercepted this aquifer.

Horizontal hydraulic gradients calculated on the uplands range from 0.01 to 0.03 in magnitude and generally trend towards the Pine Coulee. Vertical hydraulic gradients in the reservoir area are generally downwards, indicating groundwater recharge. The horizontal gradient calculated for the Stavely Buried Channel was approximately 0.002 towards the east. However, this was based on measurements from only two piezometers (A-P1 and B-P1) situated some 355 m apart and assumed that the channel was linear. Further piezometer installations in the Stavely Buried Channel are therefore advisable for the accurate determination of hydraulic gradients and flow velocities.

5. HYDROGEOLOGIC EVALUATIONS

5.1 ESTIMATE OF POTENTIAL WATER LOSSES FROM THE RESERVIOR

Potential water losses from the proposed reservoir may occur as a result of seepage:

1. Through the valley bottom and into the underlying geological formations;
2. Through the valley walls into the silty clay till and bedrock deposits; and,
3. Underneath the east bank dyke.

5.1.1 Losses Through The Valley Bottom

Water from the reservoir can be expected to seep downwards through the silty clay deposits which line the reservoir and dissipate into the underlying bedrock and the Stavely Buried Channel deposits. Estimates of this loss, using Darcy's Law, are given in Table 2.

The cross-sectional area of the reservoir bottom will vary between about 6,400,000 m^2 and 4,000,000 m^2 at the Full Supply Level (F.S.L.) and the Minimum Supply Level (M.S.L.), respectively. The hydraulic gradient will be a maximum at the dam site and decrease linearly along the length of the valley to a value of zero at the north end, thus approximating a triangular distribution. This vertical gradient will vary between a maximum of 0.70 (F.S.L.) and 0.30 (M.S.L.), for an average thickness of 10 m for the silty clay deposit and a groundwater surface 3 m below the ground elevation.

TABLE 2.

WATER LOSSES THROUGH THE VALLEY BOTTOM

RESERVOIR SUPPLY LEVEL	VERTICAL HYDRAULIC CONDUCTIVITY (m/s)	AVERAGE HYDRAULIC GRADIENT	CROSS-SECTIONAL AREA (m^2)	WATER LOSS RATE (m^3/s)
Minimum	5.0×10^{-8}	0.30	4,000,000	0.06
Minimum	2.5×10^{-8}	0.30	4,000,000	0.03
Minimum	5.0×10^{-9}	0.30	4,000,000	0.01
Full	5.0×10^{-8}	0.70	6,400,000	0.22
Full	2.5×10^{-8}	0.70	6,400,000	0.11
Full	5.0×10^{-9}	0.70	6,400,000	0.02

The value of hydraulic conductivity, K, which is appropriate for downward flow is K vertical, which is assumed to be 1/2 K horizontal due to the anisotropy inherent in sedimentary deposits. K horizontal, as determined by the hydraulic conductivity tests, is in the order of 1.0×10^{-7} to 1.0×10^{-8} m/s (based on a weighted average of conductivities for the silty clay, including high permeability silt, sand and gravel lenses).

Table 2 shows that water losses will likely vary between 0.01 and 0.06 m^3/s at the M.S.L., and 0.02 and 0.22 m^3/s at the F.S.L., depending on K. Therefore, maximum losses should not exceed 0.06 and 0.22 m^3/s while the reservoir is at the M.S.L. and F.S.L., respectively. Average losses through the valley bottom will depend on the duration the reservoir is full, or depleted, during a yearly cycle.

Assuming that the reservoir is at the F.S.L. for no more than 3 months (one quarter) of any 1 year, the loss rate would average approximately 0.10 m^3/s. Assuming that the reservoir is at the F.S.L. for no more than 6 months (one half) of any 1 year, the loss rate would average approximately 0.14 m^3/s. This latter rate is the maximum seepage rate expected through the valley bottom, based on the geological conditions found.

5.1.2 Losses Into the Valley Walls

Short term losses into the valley walls will consist primarily of water lost in saturating previously dry deposits during the initial raising of the reservoir. These losses will occur only once during the lifetime of the reservoir and due to the low hydraulic conductivity of the surrounding material, will take

place over several years. The total volume of water lost due to saturation of the surficial deposits is very difficult to determine. It is expected, however, that this loss will be negligible.

Long-term groundwater leakage through the valley walls is likely to be minimal due to the high level of the surrounding groundwater surface. The present level of the groundwater surface on the west side of the valley is above the full supply level (F.S.L. = 1054 m a.s.l.) of the reservoir (see Figure 5). Water from the reservoir will flow west until it meets this surface and then flow will be retained. The present level of the groundwater surface on the east side of the valley is below the reservoir F.S.L., but generally above the minimum supply level (M.S.L. = 1046 m a.s.l.) (see Figure 5). Therefore, water will flow east when the reservoir is full and then drain back towards the reservoir when the level is lowered to the minimum supply level.

The total volume of these flows will depend upon the time the reservoir will be above and below the surrounding groundwater elevation. This information is not available at this time. However, a conservative estimate of water losses can be made by ignoring the flow back into the reservoir during periods of low storage.

Table 3 gives an estimate of the rates of these losses using a range of horizontal K (1×10^{-7} to 1×10^{-8} m/s) for the surrounding silty clay and bedrock deposits. The cross-sectional area through which the water would flow east is about 102,400 m^2 and the horizontal gradient would likely be no greater than 0.01. Based on these assumptions, the maximum water loss should not exceed 1.0×10^{-4} m^3/s. In comparison to the total volume of the reservoir, this loss can be considered negligible.

TABLE 3.

WATER LOSSES INTO EAST VALLEY WALL

HORIZONTAL HYDRAULIC CONDUCTIVITY (m/s)	HYDRAULIC GRADIENT	CROSS-SECTIONAL AREA (m^2)	WATER LOSS RATE (m^3/s)
1.0×10^{-7}	0.01	102,400	1.0×10^{-4}
5.0×10^{-8}	0.01	102,400	5.1×10^{-5}
1.0×10^{-8}	0.01	102,400	1.0×10^{-5}

5.1.3 Seepage Losses Underneath the East Bank Dyke

Seepage losses underneath the proposed east bank dyke, near the south end of the reservoir, are also possible due to the high local gradients caused by the dyke. Table 4 shows a range of seepage rates using a range of horizontal K (1×10^{-7} to 1×10^{-8} m/s) for the underlying silty clay.

The cross-sectional area for flow underneath the dyke is about 50,000 m^2 and the horizontal gradient would likely be no greater than 0.5. Based on these assumptions, the maximum water loss should not exceed 3.0×10^{-3} m/s. In comparison to the total volume of the reservoir, this rate of loss can also be considered negligible.

5.2 PROGNOSIS OF GROUNDWATER SURFACE ELEVATIONS IN THE AREAS ADJACENT TO THE RESERVOIR

5.2.1 The Range of Influence of the Reservoir

To estimate the range of influence that the reservoir will have on the surrounding groundwater surface elevations, an empirical formula described by Pazdro (1977) was used. This formula models the reservoir as a recharging well in an unconfined aquifer (Figure 6). The range of influence was dependent on the hydraulic conductivity of the surrounding silty clays and was found not to exceed 100 m.

This is a simplistic approach, but provides an estimate of the range of influence of the reservoir to be expected. Real values may be higher, but should not exceed several hundred metres in any case. Thus, changes in the groundwater surface elevation

TABLE 4.

SEEPAGE LOSSES UNDERNEATH EAST BANK DYKE

HORIZONTAL HYDRAULIC CONDUCTIVITY (m/s)	HYDRAULIC GRADIENT	CROSS-SECTIONAL AREA (m^2)	SEEPAGE RATE (m^3/s)
1.0×10^{-7}	0.5	50,000	3.0×10^{-3}
5.0×10^{-8}	0.5	50,000	1.0×10^{-3}
1.0×10^{-8}	0.5	50,000	2.5×10^{-4}

will be limited to narrow band paralleling the Pine Coulee and of approximately the same width.

5.2.2 Changes in Surrounding Groundwater Surface Elevation

Any changes in the elevation of the surrounding groundwater surface should be upwards, because the reservoir will add water to the local groundwater regime. The maximum rise of the groundwater surface will be equal to the depth of the reservoir at the dam (21 m), since the groundwater is at, or near, the ground surface in the valley at present. Groundwater surface rises will be less northward along the Pine Coulee due to the decreasing depth of the reservoir. Groundwater surface rises will also decrease away from the Pine Coulee.

Since the present groundwater surface on the east side of the valley is slightly below the proposed F.S.L. of the reservoir, the groundwater regime on this side may be slightly altered. In particular, the groundwater divide may be moved eastward in response to reduced groundwater flow towards the reservoir. However, this should not adversely affect the reservoir level or the surrounding groundwater regime.

5.3 POTENTIAL ADVERSE EFFECTS OF THE RESERVOIR ON THE SURROUNDING AREAS

There are two potential problems which may result from the reservoir impoundment:

1. Changes in the local groundwater quality; and,
2. Flooding in areas of low topography.

5.3.1 Changes in the Local Groundwater Quality

Seasonal fluctuations in the groundwater surface will occur due to the raising and lowering of the reservoir level. The cyclic aeration and saturation caused by these fluctuations may lead to an increase in concentrations of Fe, Mn and metals and, thus, localized degradation of the groundwater quality. However, due to the low hydraulic conductivity of the silty clay deposits, it is probable that seasonal fluctuations will be small and thus, any degradation can be expected to be minimal.

The introduction of water, diverted from Willow Creek into the local groundwater regime, may affect the quality of the local groundwater, depending on the hydrochemical characteristics of both waters. It is likely, however, that any impact will be beneficial because the Willow Creek water is good quality.

5.3.2 Flooding in Areas of Low Topography

The only areas where flooding appears possible is east of the proposed east bank dyke, near the south end of the reservoir (Figure 1). This area has ground and groundwater surface elevations less than either the F.S.L. or M.S.L. of the reservoir. However, groundwater flow through the silty clay under the proposed dyke has already been estimated to be minimal. Therefore, flooding should not be a serious problem. To ensure that the minimal seepage under the dyke does not cause even localized flooding, it is advisable to construct a drainage system to collect and drain any surface, or near surface, water.

6. CONCLUSIONS

6.1 The entire site appears to be lined with a low hydraulic conductivity silty clay ($K = 1.0 \times 10^{-7}$ to 1.0×10^{-8} m/s) of glacial or alluvial origin. The underlying bedrock was tested twice for hydraulic conductivity and had a low K of 6.7×10^{-8} to 1.1×10^{-9} m/s.

6.2 The Stavely Buried Channel was tested twice during the field program for hydraulic conductivity and had an intermediate K of 4.9×10^{-6} to 5.0×10^{-7} m/s. This channel is a confined aquifer and is overlain by low hydraulic conductivity silty clay, which likely hydraulically separates it from the proposed reservoir. However, the extent and hydrogeological properties of the channel are unproven and it may have the potential to act as a drain if a hydrogeological window opens to the reservoir.

6.3 Water losses from the reservoir into surrounding geological formations would be primarily through the valley bottom and should not exceed 0.14 m^3/s. Water losses through the valley walls and underneath the east bank dyke area will likely be less than 1.0×10^{-3} m^3/s.

6.4 A rise in groundwater surface elevations will occur in the areas adjacent to the reservoir and will be less than the maximum depth of 21 m of the reservoir. Due to the low hydraulic conductivity values of the surrounding geologic formations, the radius of influence of the reservoir on the groundwater surface elevation should be limited to, at most, several hundred metres.

6.5 Flooding in areas adjacent to the valley will not likely be a problem due to the high ground surface relative to the proposed reservoir level. East of the proposed east bank dyke, where the ground and groundwater surface is lower than the reservoir level, minimal seepage may occur. If a proper drainage system is constructed, any near surface and surface flow can be intercepted and flooding will likely not occur.

6.6 The quality of the groundwater surrounding the reservoir will likely be minimally affected by the introduction of new water to the groundwater regime and by seasonal fluctuations in the reservoir level.

6.7 No serious negative hydrogeological impact of the reservoir on the surrounding area was identified. In general, the hydrogeological conditions should be considered favourable for the proposed reservoir. Slope stability considerations, possible effects of the reservoir on the dam and seepage through the dam foundations and abutments were not addressed in this study.

7. RECOMMENDATIONS

7.1 Due to the large area of the reservoir, further limited drilling and test pitting should be performed to provide more control on the local geology and hydraulic properties of the soil and bedrock, as well as on groundwater surface elevations. The slopes of the Pine Coulee should be test pitted to investigate the nature and thickness of the overlying silty clay.

7.2 The Stavely Buried Channel should be more accurately delineated and aquifer tested to determine its hydrogeological properties and those of the overlying deposits.

7.3 Detailed hydrogeological mapping of the few bedrock outcrops, which are below the reservoir F.S.L., should be conducted. If their presence could have an adverse impact on the proposed reservoir integrity, the outcrops should be excavated and/or clay lined.

7.4 A seepage drainage system should be constructed to collect and drain any surface or near surface water that seeps underneath the proposed east bank dyke.

7.5 The quality of water in wells and piezometers close to the reservoir should be monitored, both before and after the reservoir is filled, to accurately define any changes in groundwater chemistry.

Respectfully Submitted By:

PITEAU ENGINEERING LTD.

Bruce J Rutherford

B.J. Rutherford, E.I.T.

Lucien Dyrszy

for Dr. T. L. Dabrowski, P. Eng.

PERMIT TO PRACTICE
PITEAU ENGINEERING LTD.
Signature 7 P C
Date Oct 25, 1985
PERMIT NUMBER: P 2607
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

8. REFERENCES

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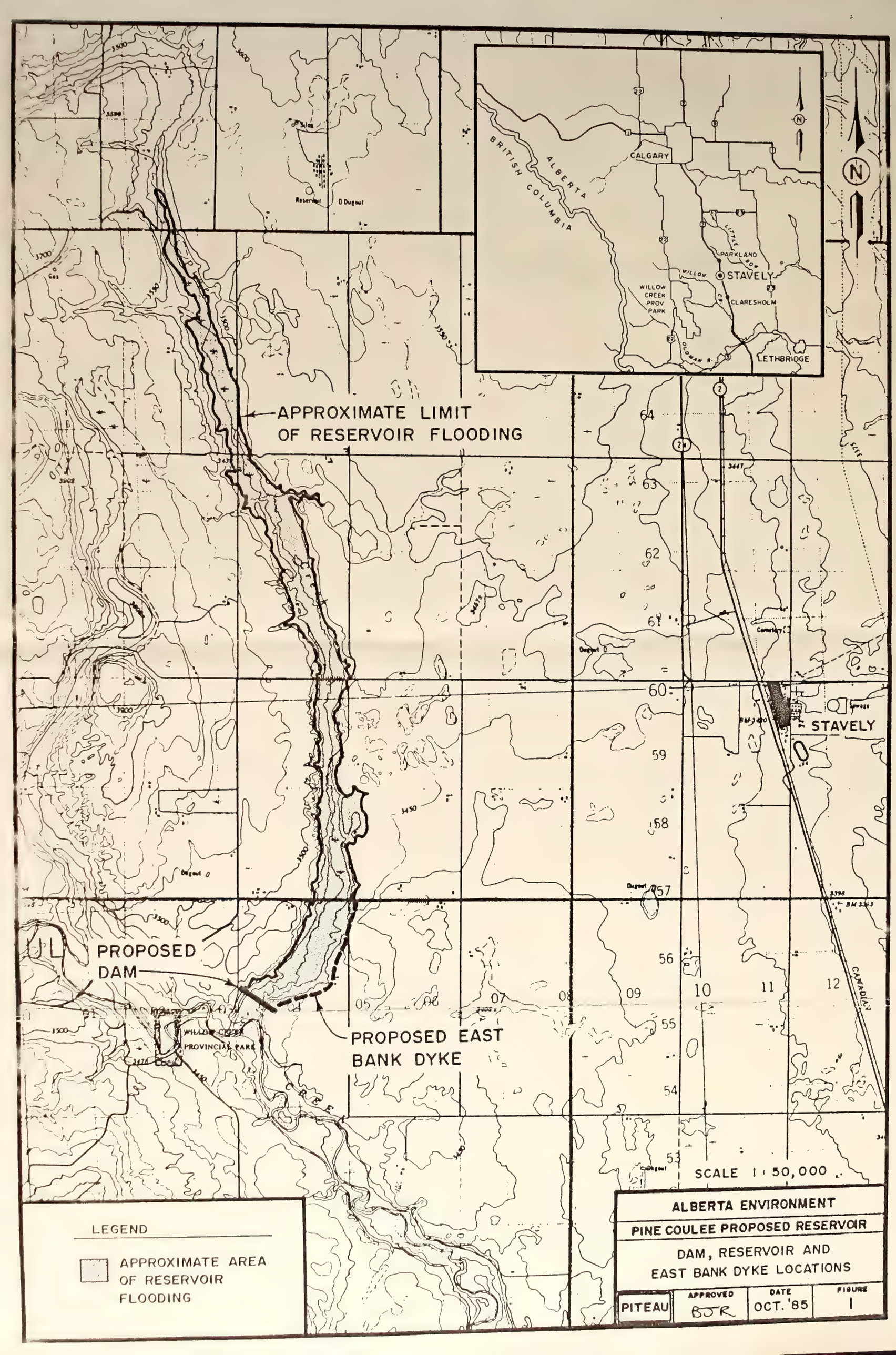
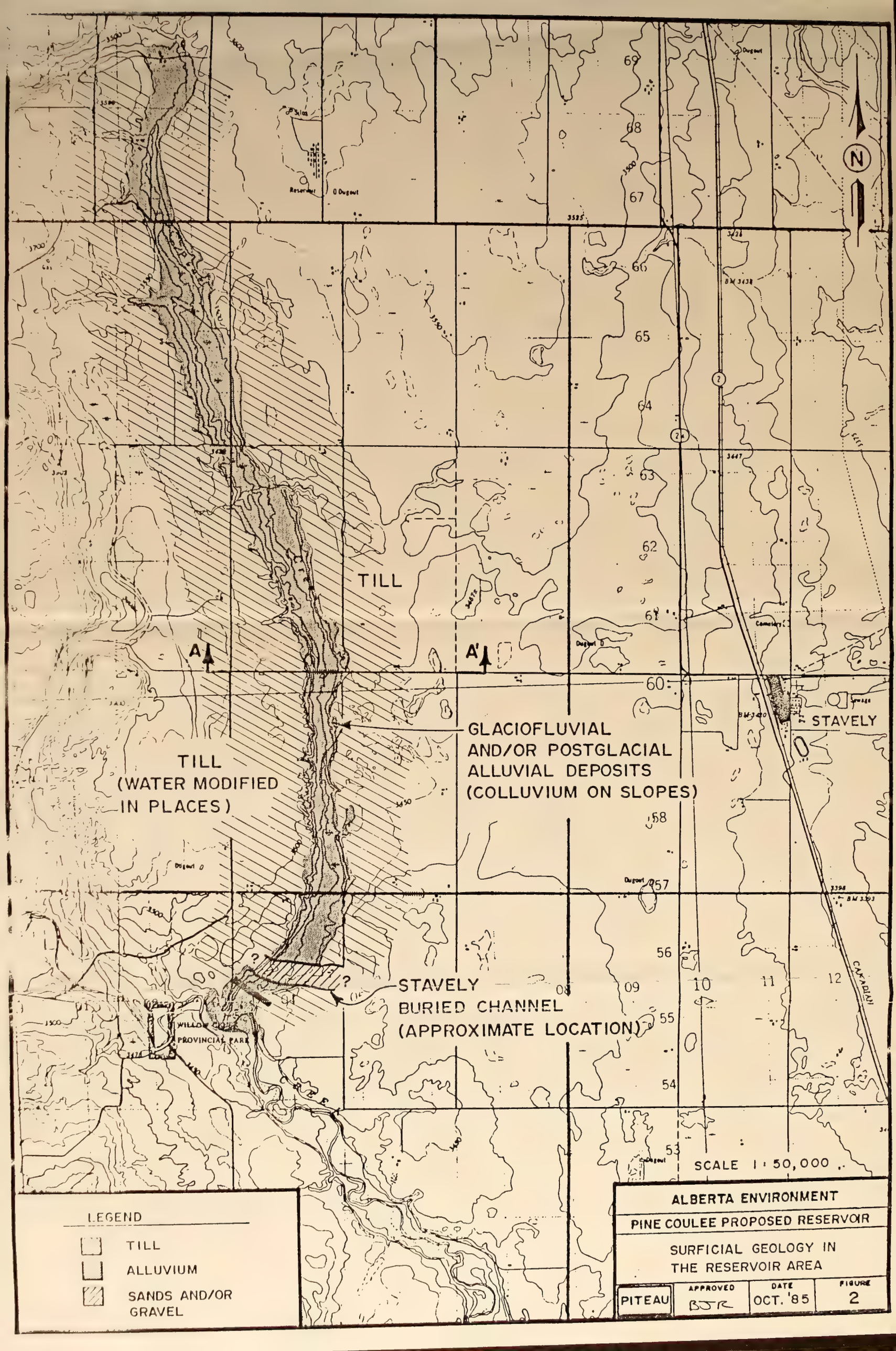
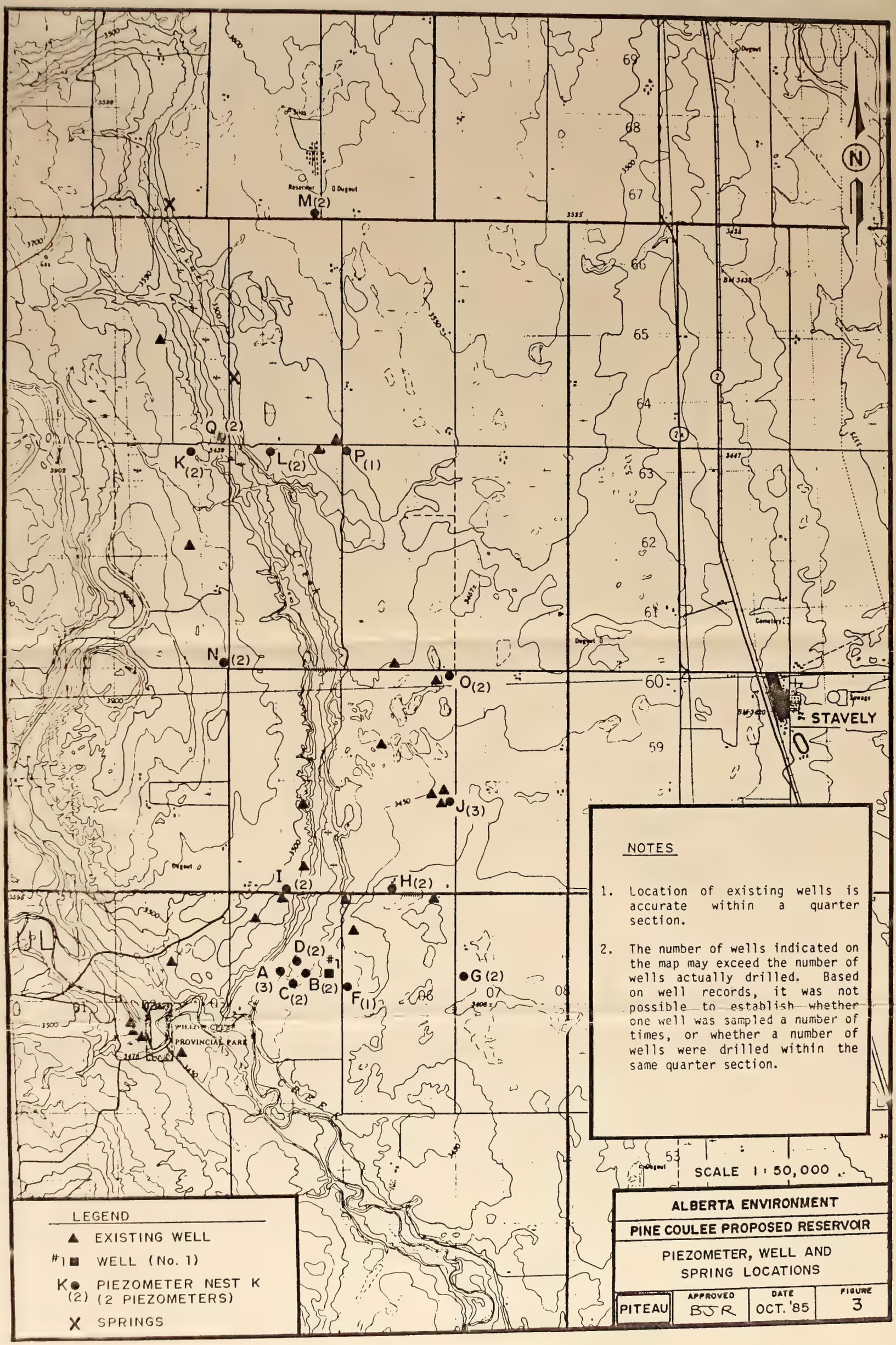
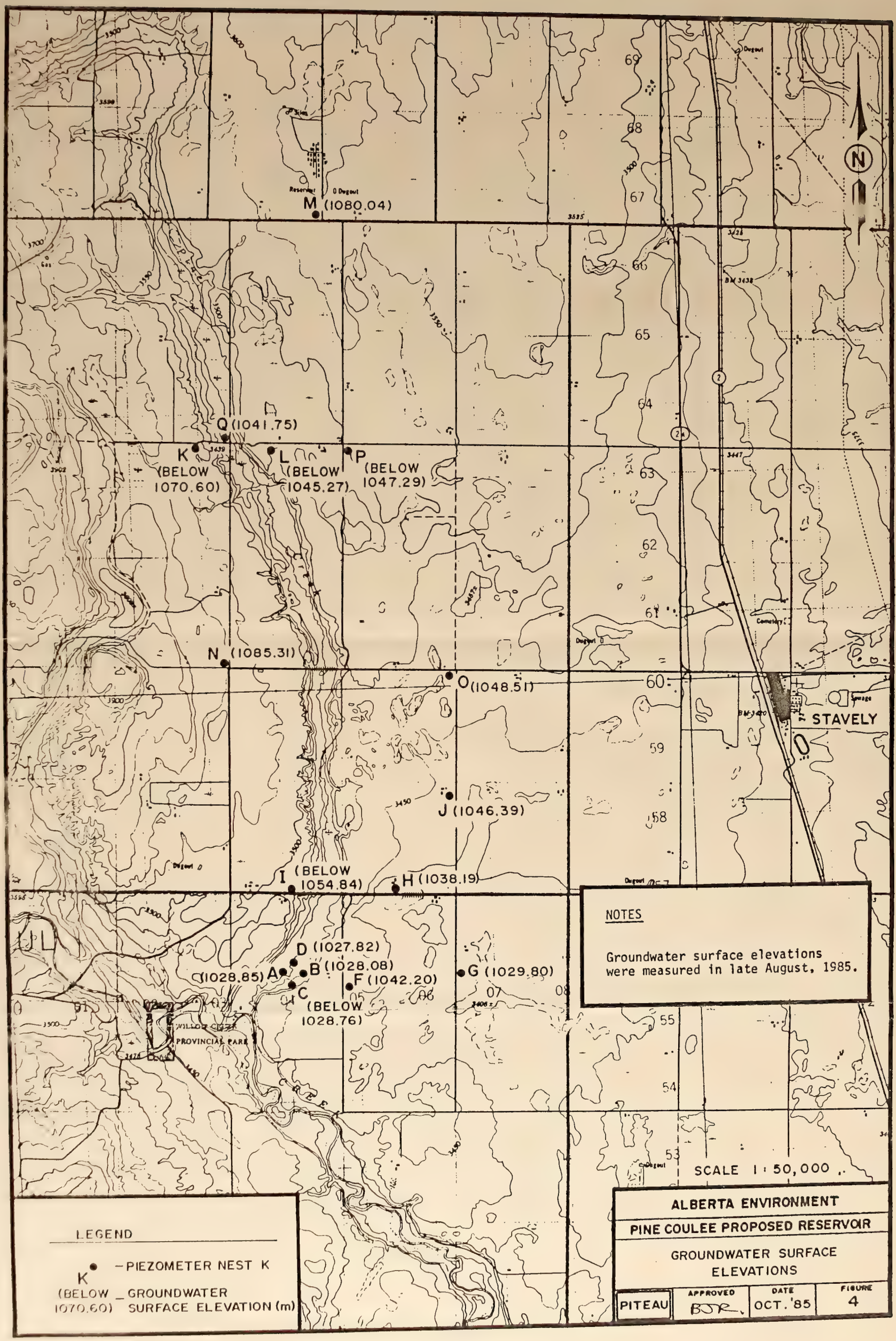
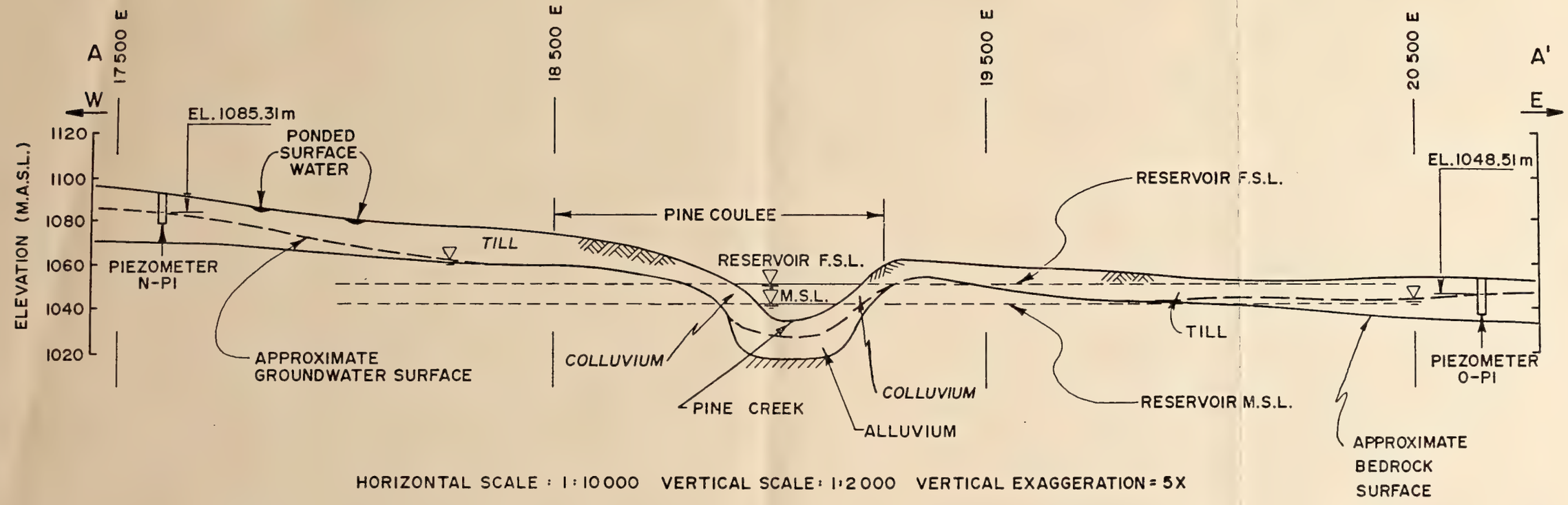

APPROXIMATE LIMIT
OF RESERVOIR FLOODING
PROPOSED
DAM
PROPOSED EAST
BANK DYKE
STAVELY
CALGARY
ALBERTA
BRITISH COLUMBIA
PARKLAND
STAVELY
WILLOW
CREEK
PROV.
PARK
CLARESHOLM
LETHBRIDGE
WILLOW CREEK
PROVINCIAL PARK
SCALE 1:50,000
LEGEND
APPROXIMATE AREA
OF RESERVOIR
FLOODING
ALBERTA ENVIRONMENT
PINE COULEE PROPOSED RESERVOIR
DAM, RESERVOIR AND
EAST BANK DYKE LOCATIONS
PITEAU
APPROVED
BJR
DATE
OCT. '85
FIGURE
1


TILL
A
A'
TILL
(WATER MODIFIED
IN PLACES)
GLACIOFLUVIAL
AND/OR POSTGLACIAL
ALLUVIAL DEPOSITS
(COLLUVIUM ON SLOPES)
STAVELY
STAVELY
BURIED CHANNEL
(APPROXIMATE LOCATION)
WILLOW CREEK
PROVINCIAL PARK
CANADIAN
N
SCALE 1:50,000
LEGEND
TILL
ALLUVIUM
SANDS AND/OR
GRAVEL
ALBERTA ENVIRONMENT
PINE COULEE PROPOSED RESERVOIR
SURFICIAL GEOLOGY IN
THE RESERVOIR AREA
PITEAU
APPROVED
BJR
DATE
OCT. '85
FIGURE
2


M(2)
Q (2)
K (2)
L (2)
P (1)
N (2)
O (2)
J (3)
I (2)
H (2)
D (2)
A (3)
B (2)
C (2)
F (1)
G (2)
#1
STAVELY
PROVINCIAL PARK
WHITE CLAY
Reservoir
Dugout
Cemetery
N
SCALE 1 : 50,000
NOTES
1. Location of existing wells is accurate within a quarter section.
2. The number of wells indicated on the map may exceed the number of wells actually drilled. Based on well records, it was not possible to establish whether one well was sampled a number of times, or whether a number of wells were drilled within the same quarter section.
LEGEND
EXISTING WELL
#1 WELL (No. 1)
K (2) PIEZOMETER NEST K (2 PIEZOMETERS)
SPRINGS
ALBERTA ENVIRONMENT
PINE COULEE PROPOSED RESERVOIR
PIEZOMETER, WELL AND SPRING LOCATIONS
PITEAU
APPROVED BJR
DATE OCT. '85
FIGURE 3

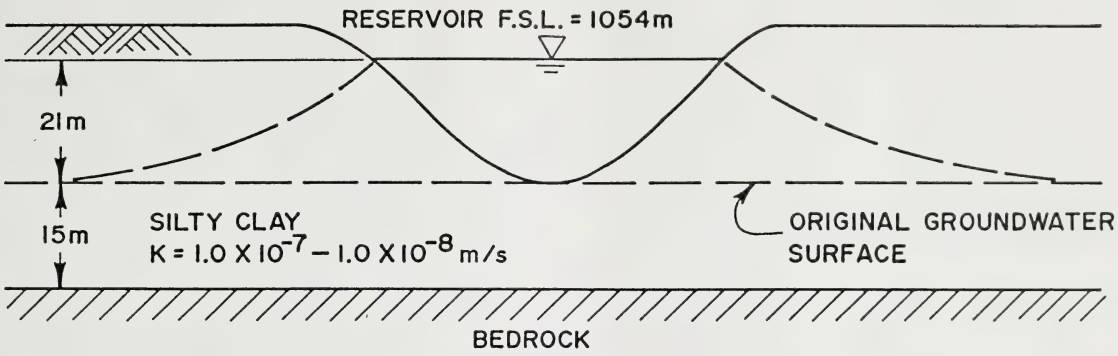

M (1080.04)
Q (1041.75)
K (BELOW 1070.60)
L (BELOW 1045.27)
P (BELOW 1047.29)
N (1085.31)
O (1048.51)
STAVELY
J (1046.39)
I (BELOW 1054.84)
H (1038.19)
D (1027.82)
B (1028.08)
(1028.85) A
C (BELOW 1028.76)
F (1042.20)
G (1029.80)
WILLOW CREEK PROVINCIAL PARK
NOTES
Groundwater surface elevations were measured in late August, 1985.
LEGEND
K ● – PIEZOMETER NEST K
(BELOW 1070.60) – GROUNDWATER SURFACE ELEVATION (m)
SCALE 1:50,000
ALBERTA ENVIRONMENT
PINE COULEE PROPOSED RESERVOIR
GROUNDWATER SURFACE ELEVATIONS
PITEAU
APPROVED BJR
DATE OCT. '85
FIGURE 4



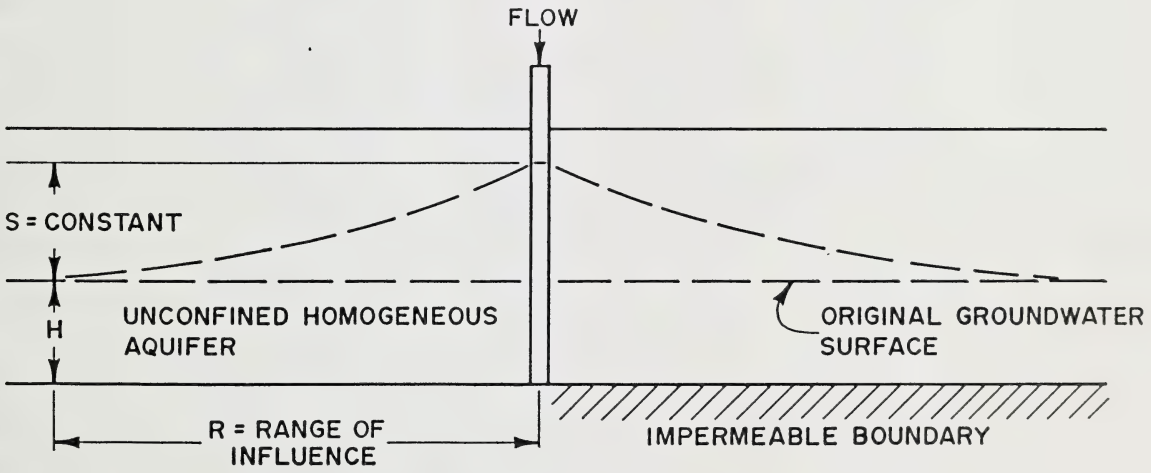
HORIZONTAL SCALE : 1:10000 VERTICAL SCALE: 1:2000 VERTICAL EXAGGERATION = 5X

ALBERTA ENVIRONMENT	PITEAU & ASSOCIATES GEOTECHNICAL CONSULTANTS VANCOUVER CALGARY	
PINE COULEE PROPOSED RESERVOIR		
HYDROGEOLOGICAL CROSS-SECTION AA' (5558450 N)	BY: W.K.	DATE: OCT. '85
	APPROVED: BJR	FIGURE: 5

RESERVOIR



RECHARGING WELL
(CONSTANT HEAD)



(EMPIRICAL FORMULA)

$$R = (S)(575)\sqrt{HK}$$

where: K = Hydraulic Conductivity (m/s)
H = Thickness of Aquifer (m)
S = Constant Head Height (m)

ALBERTA ENVIRONMENT			
PINE COULEE PROPOSED RESERVOIR			
RANGE OF INFLUENCE OF RESERVOIR USING RECHARGING WELL ANALOGY			
PITEAU	APPROVED BJK	DATE SEP/85	FIGURE 6

SITE SURVEY RESULTS

D. A. Watt Consulting Group Ltd.
CONSULTING ENGINEERS AND LAND SURVEYORS

David A. Watt, P. Eng.
Tom C. Medlicott, A.L.S.
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#101, 112 - 28th Street S.E.
Calgary, Alberta T2A 6J9
Telephone (403) 273-9001

7401

September 12, 1985.

Alberta Environment,
3rd Floor, 4920 - 51st Street,
Red Deer, Alberta.
T4N 6K8

ATTENTION: Mr. D. Hubbard.

Dear Sir:

Re: Willow Creek -
Piezometer Locations and Elevations.

Please find enclosed our original Field Notes for the above noted project. Also enclosed is our summary of co-ordinates and elevations, compiled on the attached Table.

Please contact the writer should you require any further information.

Yours truly,

Tom Medlicott, A.L.S.,
Survey Manager.

TM/myw
Enc.

c.c. Piteau Engineering
ATTN: Mr. B. Rutherford

WILLOW CREEK PIEZOMETERS

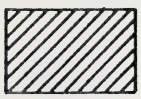
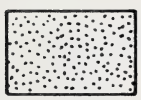
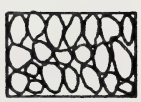
LISING OF HORIZONTAL "SEA LEVEL" CO-ORDINATES AND GEODETIC ELEVATIONS.

PIEZOMETER	CO-ORDINATES		ELEVATIONS		
NAME	NORTHING	EASTING	CASING (N.RIM)	PLASTIC PIPE ELEVATION	GROUND ELEVATION
A(P1)	5554039.517	18310.419	1034.147	1034.027	1033.683
A(P2)	5554039.896	18312.464	1034.150	1034.024	1033.647
A(P3)	5554037.927	18312.283	1034.196	1034.124	1033.692
B(P1)	5554013.059	18666.674	1034.428	1034.293	1033.813
B(P2)	5554014.462	18666.267	1034.373	1034.268	1033.783
C(P1)	5553856.670	18515.985	1034.443	1034.296	1033.827
C(P2)	5553856.446	18513.254	1034.390	1034.245	1033.842
D(P1)	5554184.043	18520.420	1034.100	1033.957	1033.629
D(P2)	5554183.645	18519.109	1034.141	1033.987	1033.644
F	5553897.237	19249.228	1046.343	1046.231	1045.809
G(P1)	5554084.888	20867.817	1042.630	1042.549	1042.074
G(P2)	5554083.292	20867.632	1042.634	1042.456	1042.064
H(P1)	5555205.480	19934.045	1042.451	1042.328	1041.932
H(P2)	5555205.578	19932.298	1042.414	1042.269	1041.952
I(P1)	5555199.615	18417.848	1063.463	1063.371	1062.971
I(P2)	5555199.612	18416.707	1063.729	1063.627	1063.071
J(P1)	5556629.493	20840.020	1051.252	1051.137	1050.700
J(P2)	5556630.881	20840.175	1051.238	1051.063	1050.770
J(P3)	5556631.928	20840.215	1051.339	1051.221	1050.760
K(P1)	5561658.027	17156.446	1085.432	1085.327	1084.922
K(P2)	5561658.177	17157.883	1085.412	1085.234	1084.932
L(P1)	5561655.578	18161.047	1060.427	1060.202	1059.918
L(P2)	5561655.541	18162.480	1060.345	1060.269	1059.818
M(P2)WEST	5564892.874	18845.697	1093.191	1093.069	1092.697
M(P1)EAST	5564892.896	18847.365	1093.189	1093.095	1092.687
N(P1)	5558466.644	17575.896	1095.943	1095.833	1095.375
N(P2)	5558468.244	17575.916	1095.924	1095.803	1095.364
O(P1)	5558428.552	20655.704	1055.241	1055.162	1054.680
O(P2)	5558428.604	20656.910	1055.297	1055.008	1054.682
P	5561649.623	19208.156	1065.252	1065.122	1064.692
Q(P1)	5561698.632	17569.922	1044.320	1044.175	1043.790
Q(P2)	5561700.820	17569.856	1044.247	1044.127	1043.717

Prepared by:
D. A. WATT CONSULTING GROUP LTD.

September 12, 1985

BOREHOLE LOGS AND PIEZOMETER COMPLETION DETAILS

LEGEND	MODIFIED U.S.C. CLASSIFICATION
ORGANIC TOPSOIL, LOW PLASTICITY	OL
SILT, LOW PLASTICITY	ML
CLAY, LOW PLASTICITY	CL
 CLAY, INTERMEDIATE PLASTICITY	CI
CLAY, HIGH PLASTICITY	CH
 SAND, WITH SILT ON CLAY	SM, SC
 GRAVEL, WITH CLAY	GC
SHALE	
SANDSTONE	

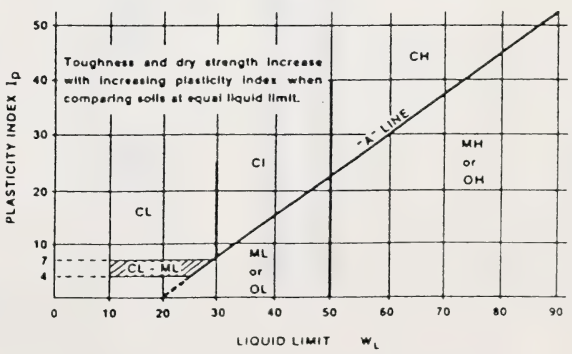
SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.)

MAJOR DIVISION			GROUP SYMBOL	GRAPHIC SYMBOL	COLOR CODE	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
HIGHLY ORGANIC SOILS			Pt		ORANGE	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE	
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS MORE THAN HALF COARSE FRACTION LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS	GW		RED	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, < 5% FINES	$C_U = \frac{D_{60}}{D_{10}} > 6 \quad C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP		RED	POORLY-GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, < 5% FINES	NOT MEETING ALL ABOVE REQUIREMENTS	
		DIRTY GRAVELS	GM		YELLOW	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES > 12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR $I_p < 4$	
			GC		YELLOW	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES > 12% FINES	ATTERBERG LIMITS ABOVE "A" LINE, $I_p > 7$	
	SANDS MORE THAN HALF COARSE FRACTION SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS	SW		RED	WELL-GRADED SANDS, GRAVELLY SANDS, < 5% FINES	$C_U = \frac{D_{60}}{D_{10}} > 4 \quad C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			SP		RED	POORLY-GRADED SANDS, OR GRAVELLY SANDS, < 5% FINES	NOT MEETING ALL ABOVE REQUIREMENTS	
		DIRTY SANDS	SM		YELLOW	SILTY SANDS, SAND-SILT MIXTURES > 12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR $I_p < 4$	
			SC		YELLOW	CLAYEY SANDS, SAND-CLAY MIXTURES > 12% FINES	ATTERBERG LIMITS ABOVE "A" LINE OR $I_p > 7$	
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE SIZE)	SILTS BELOW "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		ML		GREEN	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	$W_L < 50$	SEE CHART BELOW
			MH		BLUE	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	$W_L > 50$	
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		CL		GREEN	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	$W_L < 30$	
			CI		GREEN-BLUE	INORGANIC CLAYS OF MEDIUM PLASTICITY SILTY CLAYS	$W_L > 30, < 50$	
			CH		BLUE	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	$W_L > 50$	
	ORGANIC SILTS & ORGANIC CLAYS BELOW "A" LINE ON PLASTICITY CHART		OL		GREEN	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	$W_L < 50$	
			OH		BLUE	ORGANIC CLAYS OF HIGH PLASTICITY	$W_L > 50$	

1. All sieve sizes mentioned on this chart are U.S. Standard, ASTM E11.
2. Boundary classifications possessing characteristics of two groups are given combined group symbols eg GW-GC is a well-graded gravel-sand mixture with clay binder between 5% and 12%.
3. Soil fractions and limiting textural boundaries are in accordance with the Unified Soil Classification System, except that an inorganic clay of medium plasticity (CI) is recognized.
4. The following adjectives may be employed to define percentage ranges by weight of minor components:

and	50 - 36%
some	35 - 21%
little	20 - 11%
trace	10 - 1%

PLASTICITY CHART



PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 8, 1985
Boring No. A-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554039.517 m | Easting 18310.419 m | Elevation 1033.683 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM ⊙ LIQUID LIM
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		HSA (203 mm Ø hole) ICE					
		dry	AS			steel casing	
1		hard damp	TP				
		CH, brown-grey, mottled, some silt, stiff, blocky, minor organics.	SS				
2		moist, grey.				backfill	
			TP				
3							
4		ML lenses, dark brown-grey, firm, wet.	TP				
			SS				
5							▽ (Aug 29, 1985)
		moist, grey.	TP				
6		ML lenses up to 2.5 cm thick, wet.					
7		some silty fine-grained sand, medium grey-brown.	TP				
			SS				
8		CI, clay, little silt, medium grey, firm-stiff, with sandy silt lenses.					
		soft	TP				
9		15 cm of shale.					

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 8, 1985
Boring No. A-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554039.517 m | Easting 18310.419 m | Elevation 1033.683 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION HSA ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
11		gravel, sub-rounded.					
12		CI, clay, trace silt, dark grey, very stiff-hard, with sand silt lenses.	TP			backfill	
13							
14		silty sand lenses, medium grey-brown, fine-grained, ≤3.5 cm thick.	TP				
15							
16		sub-rounded gravel up to 2.0 cm Ø.	TP			bent seal	
17						Frac sand	
18		GC, medium grey, sub-rounded, poorly sorted, > 12% fines, gravel (up to 4 cm Ø).	SS		K = 5.0 x 10⁻⁷ m/s	screen	
19							

△ Fail 153 kPa

NOTES:

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GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 3 of 3

Contract No. A85-2097 | Compiled By B.W. Rutherford | Boring Date August 8, 1985
Boring No. A-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554039.517 m | Easting 18310.419 m | Elevation 1033.683 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION (HSA / ICE)	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		GC, as above.			K	Frac sand screen	
21		SSt., medium grey, medium-fine grained, very hard. Possibly bedrock.	SS				
		End of Hole @ 20.57 m. (Drill unable to penetrate)					

For 30 hr

NOTES:

JOB NO. 2097 BORING NO. A-P1

PITEAU ENGINEERING LTD.
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OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097
Boring No. A-P2
Northing 5559039.896 m.

Compiled By B.J. Rutherford.
Location Pine Coulee
Easting 18312.964 m.

Boring Date August 9, 1985
Contractor Allkind Drilling
Elevation 1033.647 m. (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in.
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Sample Type	Sample Condition	Sample Number	Other Tests	Piezometer Details
		HSA (203 mm Ø hole) ICE					
			AS			steel casing	
1		hard damp	TP				
		CI, brown-grey, mottled, some silt, stiff, blocky, minor organics.	SS				
2							
		moist, grey	TP				
3							
4		ML lenses, dark brown-grey, firm, wet.	TP				
			SS				
5							
		moist, grey	TP				(Aug 29, 1985)
6		ML lenses up to 2.5 cm thick, wet.					
7		some silty fine-grained sand, medium grey-brown.	TP			backfill	
			SS				
8		CI, little silt, medium grey, firm-stiff, with sandy silt lenses.					
			TP				
9		15 cm of shale					

NOTES:

JOB NO. 2097 BORING NO. A-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 9, 1985
Boring No. A-P2 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554039.896 m | Easting 18312.464 m | Elevation 1033.647 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		HSA (203 mm Ø hole) ICE					
11						backfill	
		gravel, sub-rounded					
12			TP				
		CI, trace silt, dark grey, very stiff-hard, with sandy silt lenses.					
13							
			TP			bent seal	
14		silty sand lenses medium grey-brown, fine-grained, 3.5 cm thick.				fine sand	
			TP		K= 4.2 X 10⁻⁶ m/s	screen	
15		End of Hole @ 15.09 m.					
16							

NOTES:

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OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097
Boring No. A-P3
Northing 5554037.927 m

Compiled By B.J. Rutherford
Location Pine Coulee
Easting 18312.283 m

Boring Date August 11, 1985
Contractor Allkind Drilling
Elevation 1033.697 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION — SSA (152 mm Ø hole) ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		dry	AS			steel casing	
1		hard damp	TP				
			SS			backfill	
2		CH, brown-grey, mottled, some silt, stiff, blocky, minor organics.					
		moist, grey	TP				
3							
4		ML lenses, dark brown-grey, firm, wet.	TP				(Aug 29, 1985)
			SS				
5						bent seal	
		moist, grey.	TP			Frac sand	
6		ML lenses up to 2.5 cm thick, wet.					screen
						$K_s = 1.3 \times 10^{-6}$ m/s	
7		End of Hole @ 6.71 m.					
8							
9							

NOTES:

JOB NO. 2097 BORING NO. A-P3

PITEAU ENGINEERING LTD.
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OFFICE REPORT ON SITE INVESTIGATION

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 9. & 10, 1985.
Boring No. B-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554013.059 m | Easting 18666.674 m | Elevation 1033.813 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		HSA (203 mm Ø hole) ICE					
1		gypsum pockets ≤2 cm Ø.	AS			steel casing	
			TP				
2		CH, little silt, dark brown-grey, very stiff, high plasticity.					
		CI					
3							
4		black organic streaks and organic odour, moist.	TP				
5		gravel in clay causing drill rig to bounce.				backfill	
			TP				(Aug 29, 1985)
6		CI, clay, some silt, medium grey, stiff, medium plasticity.					
7		very soft, silt lenses, moist.	TP				
8							
			TP				
9							

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Contract No. A85-2097
Boring No. B-P1
Northing 5554013.059 m

Compiled By B.J. Rutherford
Location Pine Coulee
Easting 18666.674 m

Boring Date August 9 & 10, 1985
Contractor Allkind Drilling
Elevation 1033.813 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION (HSA – ICE)	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		CI, as above.					
11		CH, medium grey, some silt, stiff, high plasticity, blocky.	TP			backfill	
12							
13							
14		GC, medium grey, some silt and sand, sub-rounded, up to 3 cm Ø, poorly sorted, saturated, dense. Some sandstone present.	SS			bent. seal	
15		SC, grey, some clay, fine to medium grained, uniform, saturated, dense. Sand flows up middle of hollow stem when bit removed.			K = 4.9 x 10⁻⁶ m/s	screen	
16							
17							
18			AS			Frac sand & sand slough	
19		gravel					

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 3 of 3

Contract No. A85-2097 | Compiled By B.V. Rutherford | Boring Date August 9 & 10, 1985
Boring No. B-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554013.059 m | Easting 18666.674 m | Elevation 1033.813 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION HSA ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SC, as above.				Frac sand & sand slough	
21		End of Hole @ 20.73 m.					

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 12, 1985
Boring No. B-P2 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554014.462 m | Easting 18666.267 m | Elevation 1033.783 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
1		gypsum pockets 2 cm Ø.	AS			steel casing	
2		CH, little silt, dark brown-grey, very stiff, high plasticity.	TP			backfill	
3		CI					
4		black organic streaks and organic odour, moist.	TP			bent. seal	
5		CI, clay, some silt, medium grey, stiff, medium plasticity.				Frac sand	
6		gravel in clay causing drill rig to bounce.	TP		K = 1.9 x 10⁻⁹ m/s	(Aug 29, 1985) screen	
7		very soft, silt lenses, moist.	TP				
8		End of Hole @ 7.62 m.					
9							

NOTES:

JOB NO. 2097 BORING NO. B-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 11, 1985
Boring No. C-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5553856,670 m | Easting 18515,985 m | Elevation 1033.827 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Spgl spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. | LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION (HSA (203 mm Ø hole) ICE)	Sample Type	Sample Condition	Sample Number	OTHER TESTS	PIEZOMETER DETAILS
1		damp CI, some silt, medium brown-grey, mottled, very stiff, medium-high plasticity.	AS			steel casing	
2		brown CH	TP				
3		soft	TP				
4		silty sand lenses ≤5 cm thick, fine-grained, uniform, wet.	TP			backfill	
5							
6		CI, medium grey, some silt, very soft-firm, medium plasticity.	TP				
7			TP				
8							
9						bent. seal	
		very moist. CH, medium grey, stiff, high plasticity, blocky.					

NOTES:

JOB NO. 2097 BORING NO. C-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 11, 1985
Boring No. C-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5553856.670 m | Easting 18515.985 m | Elevation 1033.827 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		HSA (203 mm Ø hole) ICE					
			TS				
11		CH, medium grey, little-some silt, stiff, high plasticity, blocky.				Frac sand	
							screen
12		silty sand layers, very moist.	TP				

NOTES:

JOB NO. 2097 BORING NO. C-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 11, 1985
Boring No. C-P2 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5553856.446 m | Easting 18513.254 m | Elevation 1033.842 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
1		damp	AS			steel casing	
		CI, some silt, medium brown-grey, mottled, very stiff, medium-high plasticity.	TP			backfill	
2		brown					
		CH	TP				
3		soft				bent seal	
4		silty sand lenses, ≤5 cm thick, fine-grained, uniform, wet. CI, medium grey, some silt, very soft-firm, medium plasticity.	TP			Frac sand	
5			AS			screen	
		End of Hole @ 5.49 m.					Dry (Aug 29, 1985)
6							
7							
8							
9							

K = 6.6 x 10⁻⁹ m/s

NOTES:

JOB NO. 2097 BORING NO. C-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 12, 1985
Boring No. D-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554184.043 m | Easting 18520.420 m | Elevation 1033.629 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		HSA (203 mm Ø hole) ICE					
1		dry	AS			steel casing	
		CI, grey-brown, some silt, stiff, medium-high plasticity. Increasing plasticity downwards.	TP				
2							
3							
		soft					
4		damp	TP			backfill	
5							(Aug 21, 1985)
		silt laminae ≤1 mm thick, damp.	TP				
6		CH, grey, some silt, medium-stiff consistency, high plasticity.					
7		silt layers, wet	TP				
8							
		wet					
9		SSt., dark grey and light brown, medium-fine grained, uniform. Partially weathered. Possibly bedrock.				bent seal Frac sand	

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097 | Compiled By B.V. Rutherford | Boring Date August 12, 1985
Boring No. D-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554184.043 m | Easting 18520.420 m | Elevation 1033.629 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		HSA (203 mm Ø hole) ICE					
11		SSt., dark grey and light brown, medium-fine grained, uniform. Partially weathered. Possibly bedrock.	SS		K=6.7x10⁻⁸m/s	Frac sand	screen
			SS				
		End of Hole @ 11.73 m.					

NOTES:

JOB NO. 2097 BORING NO. D-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 12, 1985
Boring No. D-P2 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554183.645 m | Easting 185199.109 m | Elevation 1033.644 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM
10 30 50 70 90

SSA (152 mm Ø hole) ICE

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
1		dry	AS			steel casing	
		CI, grey-brown, some silt, stiff, medium-high plasticity. Increasing plasticity downwards.	TP				
2						backfill	
3							
4		soft, damp	TP				
5		CH, grey, some silt, medium-stiff consistency, high plasticity.				bent. seal	
6		silt laminae 1 mm thick, damp.	TP		K=7.5 x 10⁻⁷ m/s	Frac sand	CAN 29, 1985
7		silt layers, wet.	TP			screen	
8		End of Hole @ 7.32 m.					
9							

NOTES:

JOB NO. 2097 BORING NO. D-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097 | Compiled By B.W. Rutherford | Boring Date August 13, 1985
Boring No. F-P1 | Location Pjoe Coulee | Contractor Allkind Drilling
Northing 5553897.237 m | Easting 19249.228 m | Elevation 1045.809 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Sample Type	Sample Condition	Sample Number	OTHER TESTS	PIEZOMETER DETAILS
		HSA (203 mm Ø hole) ICE					
		OL, topsoil.	AS			steel casing	
	CL-CH						
1		CL (till), medium brown, some-little silt, stiff, with sub-rounded erratics ≤ 2 cm Ø. Boulders throughout.	TP				
2							
		gypsum pockets ≤2 cm Ø.	TP			backfill	
3		boulders.					
4		dry-damp.	AS			bent. seal	
5							
		dry-damp.	SS			screen	
			TP				
		boulders.					
6		ML (till), medium brown, some sand and clay, very dense, with sub-rounded erratics. Increasing clay content with depth.				Frac sand	
			TP				
			AS				
7		End of Hole @ 6.71 m. (Drill unable to penetrate)					
8							
9							

K = 1.9 x 10⁻⁸ m/s

(Aug 23, 1985)

F-P1 IS2

NOTES:

JOB NO. 2097 BORING NO. F-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097
Boring No. G-P1
Northing 5554084.888 m
Compiled By B.J. Rutherford
Location Pine Coulee
Easting 20867.817 m
Boring Date August 13, 1985
Contractor Allkind Drilling
Elevation 1042.074 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		HSA (203 mm Ø hole) ICE	AS			steel casing	
1		loose, non-plastic, dry.					
2						backfill	
		ML-CL (till), brown, silt and clay, trace fine-grained sand, low plasticity, medium-stiff consistency. Increasing clay content with depth.	AS				
3							
		boulders					
4			AS				
5						bent seal	
6		damp	AS				
							Frac sand & slough
7					K=9.6×10⁻⁹ m/s		
		CI, stiff.					screen
8							
		CI (till), grey, some silt, very stiff, with sub-rounded erratics ≤ 3 cm Ø.	AS				
9		End of Hole @ 8.84 m.					Dry (Aug 24, 1985)

NOTES:

JOB NO. 2097 BORING NO. G-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Contract No. A85-2097
Boring No. G-P2
Northing 5554083.292 m
Compiled By B.J. Rutherford
Location Pine Coulee
Easting 20867.632 m
Boring Date August 13, 20, 22, 1985
Contractor Allkind Drilling
Elevation 1042.064 m (Ground)

SAMPLE TYPES

AS	Auger sample	TO	Thin wall open
WS	Wash sample	TP	Thin wall piston
RC	Rock core		
CR	CRREL barrel		
SS	Split spoon		

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION: Disturbed; Fair; Good; Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
		OL, topsoil.	AS			steel casing	
1		loose, non-plastic, dry.					
2		ML-CL (till), brown, silt and clay, trace fine-grained sand, low plasticity, medium-stiff consistency. Increasing clay content with depth.	AS				
3							
4		boulders	AS				
5						backfill	
6		damp	AS				
7		CI, stiff					
8							
9		Fe-stained slst & sh. CI (till), grey, some silt, medium plasticity, very stiff, with sub-rounded erratics ≤ 3 cm Ø.	AS				

NOTES:

JOB NO. 2097 BORING NO. G-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Contract No. A85-2097 | Compiled By B.V. Rutherford | Boring Date August 13, 20, 22, 1985
Boring No. G-P2 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5554083.292 m | Easting 20867.632 m | Elevation 1042.064 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
11		brown Cl layers ≤2 mm thick.	AS			backfill	(Aug 28, 1985)
12		Cl (till), grey, some silt, medium-high plasticity, very stiff, with sub-rounded erratics ≤ 2 cm Ø.	AS				
13							
14		grey-brown	AS				
15			AS				
16							
17			AS				
18							
19		damp	AS				

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 3 of 3

Contract No. A85-2097
Boring No. G-P2
Northing 5554083.292 m
Compiled By B.J. Rutherford
Location Pine Coulee
Easting 20867.632 m
Boring Date August 13, 20, 22, 1985
Contractor Alking Drilling
Elevation 1042.068 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. 10 30 LIQUID LIM. 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole). ICE					
21							
22		moist	AS				
23		CI (till), grey, some silt, medium-high plasticity, very stiff, with sub-rounded erratics.				backfill	
24							
25		dark grey	AS				
26						bent. seal	
27						screen	
28					K = 3.4 x 10⁻⁷ m/s		
29		wet	AS			Frac sand	

NOTES: End of Hole @ 30.02 m.

JOB NO. 2097 BORING NO. G-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 14, 1985
Boring No. H-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5555205.480 m | Easting 19934.045 m | Elevation 1041.932 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth	Symbol	SOIL/ROCK DESCRIPTION HSA (203 mm Ø hole) ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		OL, topsoil.	AS			steel casing	
1		—dry ML, dark brown, and clay, loose, non-plastic. Probably till.	AS				
2							
3		boulders SM, light brown-grey, medium-grained, poorly sorted, dirty. Sub-rounded erratics ≤ 2.5 cm Ø.	TP				Aug 25, 1985
4						backfill	
5		— damp ML - CL (till), brown-grey, silt and clay, stiff, low plasticity. Sub-rounded erratics and ≤ 5 mm long black carbonaceous inclusions.	SS				
6		Fe-stained sand laminae ≤ 0.5 mm thick.	TP				
7		low-medium plasticity. CI (till), grey, some-trace silt, stiff, medium-low plasticity. Sub-rounded erratics ≤ 5 cm Ø and fine-grained sand laminae.	TP				
8							
9		sand laminae 0.5 mm thick, not Fe-stained.				bent seal	
		wet					

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 14, 1985
Boring No. H-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5555205.480 m | Easting 19934.045 m | Elevation 1041.932 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 truck mounted
SAMPLE HAMMER wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		HSA (203 mm Ø hole) ICE					
11		sand laminae, not Fe-stained.	AS			screen	
12		CI (till), grey, some-trace silt, medium-low plasticity, with sub-rounded erratics.	TP		K = 1.9 x 10⁻⁸ m/s	Frac sand	
13		wet	AS			bent seal	
		End of Hole @ 13.72 m.					

NOTES:

JOB NO. 2097 BORING NO. H-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097
Boring No. H-P2
Northing 5555205.578 m

Compiled By B.J. Rutherford
Location Pine Coulee
Easting 19932.298 m

Boring Date August 14, 1985
Contractor Allkind Drilling
Elevation 1041.952 m (Ground)

SAMPLE TYPES

AS	Auger sample	TO	Thin wall open
WS	Wash sample	TP	Thin wall piston
RC	Rock core		
CR	CRREL barrel		
SS	Split spoon		

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION: Disturbed; Fair; Good; Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION (SSA (152 mm Ø hole) ICE)	Sample Type	Sample Condition	Sample Number	OTHER TESTS	PIEZOMETER DETAILS
		OL, topsoil.	AS			steel casing	
1		ML, dark brown, and clay, loose, non-plastic. Probably till. dry	AS			backfill	
2						bent seal	
3		boulders SM, light brown-grey, medium grained, poorly sorted, dirty. Sub-rounded erratics ≤ 2.5 cm Ø.	TP		K= 3.1 x 10⁻⁸ m/s	Frac sand	screen
4		End of Hole @ 3.96 m.	AS				Dry (Aug 25, 1985)
5							
6							
7							
8							
9							

NOTES:

JOB NO. 2097 BORING NO. H-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097 | Compiled By B.W. Rutherford | Boring Date August 14, 1985
Boring No. I - P1 | Location Pine Coulee | Contractor Alkind Drilling
Northing 5555199.615 m | Easting 18417.848 m | Elevation 1062.971 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth	Symbol	SOIL/ROCK DESCRIPTION (HSA (203 mm Ø) and SSA (152 mm Ø))	ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		OL, topsoil.		AS			steel casing	
1		dry		TP				
2		ML (till), light brown, and clay, trace fine-grained sand, low plasticity, medium consistency with sub-rounded erratics ≤ 2 cm Ø.						
3							backfill	
4		damp, grey		TP				
5								
6				TP				
				SS			bent seal	
7		ML - CL (till), brown, silt and clay, low plasticity, stiff, with sub-rounded erratics ≤ 10 cm.		AS		K=1.6×10⁻⁷ m/s	Frac sand	
8		damp sandstone and shale layers.		AS			screen	
9		End of Hole @ 8.53 m. (Possible bedrock)						Dry (Aug 25, 1985)

Fair 152 kPa

NOTES:

JOB NO. 2017 BORING NO. I - P.1.

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097
Boring No. I-P2
Northing 5555199.612 m
Compiled By B.J. Rutherford
Location Pine Coulee
Easting 18816.707 m
Boring Date August 16, 1985
Contractor Allkind Drilling
Elevation 1063.071 m. (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in.
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
		OL, topsoil.	AS			steel casing	
1		dry	TP			backfill	
		ML (till), light brown, and clay, trace fine-grained sand, low plasticity, medium consistency with sub-rounded erratics ≤ 2 cm Ø.				bent seal	
2							
						Frac sand	
3							
		damp, grey.				screen	
4			TP				
			AS				
		End of Hole @ 4.57 m.					Dry (Aug 25, 1985)
5							
6							
7							
8							
9							

K=3.3 x 10⁻³ m/s

NOTES:

JOB NO. 2097 BORING NO. I-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097
Boring No. J-P1
Northing 5556629.493 m
Compiled By B.L. Rutherford
Location Pine Coulee
Easting 20840.020 m
Boring Date August 15, 1985
Contractor Allkind Drilling
Elevation 1050.700 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

SSA (152 mm Ø hole) ICE

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		OL, topsoil.	AS			steel casing	
1		dry	TP				
2		Cl. - ML (till), brown-grey, clay and (some) silt, medium-stiff consistency, low plasticity. Sub-rounded erratics ≤ 3 cm.				backfill	
3							(Aug 25, 1985)
4		damp	TP				
5						bent. seal	
6		moist				Frac sand	
		Fe-stained joints or horizontal surfaces.	SS			screen	
7			AS			K= 6.6 x 10⁻⁷ m/s	
		End of Hole @ 7.01 m.					
8							
9							

NOTES:

JOB NO. 2097 BORING NO. J-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. AB5-2097 | Compiled By B.J. Rutherford | Boring Date August 10, 1985
Boring No. J-P2 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5556630.881 m | Easting 20840.175 m | Elevation 1050.770 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
		OL, topsoil.	AS			steel casing	
1		dry	TP			backfill	
		CL - ML (till), brown-grey, clay and (some) silt, medium-stiff consistency, low plasticity. Sub-rounded erratics ≤ 3 cm.				bent. seal	
2							
3						Frac sand	
						$K = 9.0 \times 10^{-8}$ m/s	
4		damp	TP			screen	
		End of Hole @ 4.27 m.					Dry (Aug 26, 1985)
5							
6							
7							
8							
9							

NOTES:

JOB NO. 2097 BORING NO. J-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 3

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 15 & 16, 1985
Boring No. J - P3 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5556631.928 m | Easting 20840.215 m | Elevation 1050.760 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth	Symbol	SOIL/ROCK DESCRIPTION (SSA (152 mm Ø hole) ICE)	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		OL, topsoil	AS			steel casing	
1		dry	TP				
2		CL - ML (till), brown-grey, clay and (some) silt, medium-stiff consistency, low plasticity. Sub-rounded erratics ≤ 3 cm.					
3							
4		damp	TP				
5						backfill	
6		moist	SS				
7		Fe - stained joints or horizontal surfaces.	SS				
8		CL (till), light brown, some silt, very stiff, low plasticity, with sub-rounded erratics.					
9		moist	AS				
		CI (till), grey, a little silt.					

NOTES:

JOB NO. 2097 BORING NO. J - P3

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Contract No. A85-2097
Boring No. J-P3
Northing 5556631.928 m
Compiled By B.J. Rutherford
Location Pine Coulee
Easting 20840.215 m
Boring Date August 15. & 16., 1985.
Contractor Allkind Drilling
Elevation 1050.760 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth	Symbol	SOIL/ROCK DESCRIPTION SSA (152 mm Ø hole) ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS (Aug 27, 1985)
		moist					
11							
12			AS				
		Cl (till), grey, a little to some silt, medium-stiff consistency, with sub-rounded erratics.					
13							
		Fe - stained silty sst. layers ≤ 15 cm.					
14							
15			AS				
16						backfill	
		moist-wet					
17						bent. seal	
18		wet	AS			Frac sand	
19					K=1.4 X 10⁻⁹ m/s	screen	

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 3 of 3

Contract No. A85-2097
Boring No. J - P3
Northing 5556631.928 m
Compiled By B.J. Rutherford
Location Pine Coulee
Easting 20840.215 m
Boring Date August 15 & 16, 1985
Contractor Allkind Drilling
Elevation 1050.760 m (Ground)

SAMPLE TYPES

AS	Auger sample	TO	Thin wall open
WS	Wash sample	TP	Thin wall piston
RC	Rock core		
CR	CRREL barrel		
SS	Split spoon		

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth	Symbol	SOIL/ROCK DESCRIPTION	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
21		CI (till), as above.	AS		K=1.4x10⁻⁹ m/s	screen Frac sand	
		End of Hole @ 21.34 m.					

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 16, 1985
Boring No. K-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5561658.027 m | Easting 17156.446 m | Elevation 1084.922 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION (HSA (203 mm ø hole) ICE)	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		OL, topsoil.	AS			steel casing	
1			TP			backfill	
2		ML, light-medium brown, little-some clay, very stiff-hard, low plasticity, with layers ≤ 15 cm thick of hard (partially indurated?) ML.	AS			bent. seal	
3						Frac sand	
4		dry	SS			screen	
5						bent. sand	
			SS			Refusal	
6		CI, medium brown-grey, some-little silt, stiff, medium plasticity, with layers of soft shale and fine-grained sandstone.				backfill	
7			AS			Refusal	
		End of Hole @ 7.01 m.				Dry (Aug 27, 1985)	
8							
9							

K = 3.3 x 10⁻⁹ m/s

NOTES:

JOB NO. 2097 BORING NO. K-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097
Boring No. K-P2
Northing 5561658.177 m
Compiled By B.J. Rutherford
Location Pine Coulee
Easting 17157.883 m
Boring Date August 17, 1985
Contractor Allkind Drilling
Elevation 1084.932 m. (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION SSA (152 mm ø hole) ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		OL, black soil, high organic content.	AS			steel casing	
1		ML, light-medium brown, little-some clay, very stiff-hard, low plasticity, with layers ≤ 15 cm thick of hard (partially indurated?) ML.	TP				
2			AS				
3							
4		dry	SS				
5							
			SS				
6		CI, medium brown-grey, some-little silt, stiff, medium plasticity, with layers of soft shale and fine-grained sandstone.					
7			AS				
						back fill	
8							
		dry	AS				
9							
		CI, grey, some-little silt.	AS				

Refusal
Refusal

NOTES:

JOB NO. 2097 BORING NO. K-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097 | Compiled By B.J. Rutherford. | Boring Date August 17, 1985.
Boring No. K-P2 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5561658.177 m | Easting 17157.883 m | Elevation 1084.932 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. | LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
11						backfill	
		dry	AS				
12						bent. seal	
		Cl, grey, some-little silt, very stiff, with layers of very hard Cl and soft siltstone and shale.					
13						Frac sand	
					K=3.4×10⁻⁹ m/s		
14						screen	
		reddish-brown Cl present.	AS				
15						bent. sand	
16							
17						backfill	
		Shale, grey, hard. Possibly bedrock.	AS				
18		End of Hole @ 17.98 m (Minimal drilling progress)					Dry (Aug 27, 1985)
19							

NOTES:

JOB NO. 2097 BORING NO. K-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Contract No. A85-2097
Boring No. L-P1
Northing 5561655.578 m
Compiled By B.J. Rutherford
Location Pine Coulee
Easting 18161.047 m
Boring Date August 17, 1985
Contractor Allkind Drilling
Elevation 1059.918 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION SSA (152 mm Ø hole) ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		OL, dark brown soil, high organic content.	AS			steel casing	
1		dry ML, light and dark brown, and clay, loose, low-medium plasticity. Increasing clay content downwards.	AS				
2			AS				
3							
4		damp	AS				
5		CI (till), dark brown, and silt, medium plasticity, stiff, with occasional sub-rounded erratics ≤ 2 cm Ø and soft layers of siltstone and shale ≤ 1 m thick.					
6			AS				
7						backfill	
8							
9		dry	AS				
		CI, grey, little silt, stiff.					

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 17, 1985
Boring No. L-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5561655.578 m | Easting 18161.047 m | Elevation 1059.918 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm ø hole) ICE					
11						backfill	
12		CI, grey, little silt, stiff, medium-high plasticity, with layers of very hard CI and soft siltstone and shale.	AS			bent seal	
13			AS		K = 6.6 x 10⁻¹⁰ m/s		
14						Frac sand	
15			AS			screen	
16		reddish-brown CI present.				bent seal	
17							
18			AS			backfill	
19		dry					
			AS				

NOTES: End of Hole @ 20.73 m.

Dry (Aug 27, 1985)

JOB NO. 2097 BORING NO. L-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097
Boring No. L-P2
Northing 5561655.541 m
Compiled By B.J. Rutherford
Location Pine Coulee
Easting 18162.480 m
Boring Date August 17, 1985
Contractor Allkind Drilling
Elevation 1059.818 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG B61 truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

SSA (152 mm Ø hole) ICE

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		OL, topsoil.	AS			steel casing	
1		dry	AS			backfill	
2		ML, light and dark brown, and clay, loose, low-medium plasticity. Increasing clay content downwards.	AS			bent. seal	
3		CI (till), dark brown, and silt, medium plasticity, stiff, with occasional sub-rounded erratics ≤ 2 cm Ø and soft layers of siltstone and shale ≤ 1 m thick.				Frac sand	
4		damp	AS			screen	
		End of Hole @ 4.57 m.			K = 5.2 x 10⁻³ m/s		Dry (Aug 27, 1985)
5							
6							
7							
8							
9							

NOTES:

JOB NO. 2097 BORING NO. L-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097
Boring No. M-P1
Northing 5564892.896 m

Compiled By B.V. Rutherford
Location Pine Coulee
Easting 18847.365 m

Boring Date August 18, 1985
Contractor Alkjod Drilling
Elevation 1092.687 m (Ground)

SAMPLE TYPES

AS	Auger sample	TO	Thin wall open
WS	Wash sample	TP	Thin wall piston
RC	Rock core		
CR	CRREL barrel		
SS	Split spoon		

TYPE OF RIG 861 truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION

- Disturbed
- Fair
- Good
- Lost

TEST INFORMATION

- PENETROMETER KN/m²
- UNCONFINED COMP STR KN/m²
- SPT N-VALUE BLOWS/0.3m
- WATER CONTENT %
- PLASTIC LIM.
- LIQUID LIM
- 10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
1		damp — CI, light and dark brown, trace silt, stiff.	AS			steel casing	
2			AS				
3		Shale, grey-green, soft.					
4		dry	AS				
5		CI, brown-grey, trace silt, hard, medium plasticity with layers of very hard CI.					
6							
7			AS			backfill	
8							
9		Shale, grey, hard.					
		CI, grey, trace silt, hard.					

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097
Boring No. M-P1
Northing 5564892.896 m

Compiled By B.J. Rutherford
Location Pine Coulee
Easting 18847.365 m

Boring Date August 18, 1985
Contractor Allkind Drilling
Elevation 1092.687 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
11		Cl, grey, trace silt, hard.	AS			backfill	(Aug 27, 1985)
						bent. seal	
12		Shale, grey, hard. Possibly bedrock.	AS			Frac sand & slough screen	
			AS				
13		End of Hole @ 12.65 m. (Drill unable to penetrate)					

NOTES:

JOB NO. 2097 BORING NO. M-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 18, 1985
Boring No. M-P2 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5564892.874 m | Easting 18845.697 m | Elevation 1092.697 m. (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
1		damp — CI, light and dark brown, trace silt, stiff.	AS			steel casing	
2			AS			backfill	
3		Shale, grey-green, soft.	AS			bent. seal	
4		dry — CI, brown-grey, trace silt, hard, medium plasticity, with layers of very hard CI.	AS			Frac sand	
5		End of Hole @ 4.57 m.				screen	Dry (Aug 29, 1985)
6						$K = 8.0 \times 10^{-9}$ m/s	
7							
8							
9							

NOTES:

JOB NO. 2097 BORING NO. M-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097
Boring No. N-P1
Northing 5558466.644 m
Compiled By B.J. Rutherford
Location Pine Coulee
Easting 17575.896 m
Boring Date August 19, 1985
Contractor Aljkind Drilling
Elevation 1095.375 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth	Symbol	SOIL/ROCK DESCRIPTION SSA (152 Ø hole) ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		OL, dark brown soil with organics.	AS			steel casing	
1		moist CL (till), light brown, some silt, stiff, low - medium plasticity, moist with sub-rounded erratics ≤ 2 cm					
2			AS				
3		GC, sub-rounded erratics, poorly sorted, dirty, ≤ 5 cm Ø.				backfill	
4		moist					
5		CL (till), brown, and silt, stiff, moist with sub-rounded erratics and layers of hard, brown clay.					
6			AS				
7		dry					
8		CI (till), grey, trace silt, stiff-hard, medium plasticity, dry - moist, with sub-rounded erratics.					
9			AS			bent. seal Frac sand screen	(Aug 24, 1985)

NOTES:

JOB NO. 2097 BORING NO. N-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097 | Compiled By R.V. Rutherford | Boring Date August 19, 1985
Boring No. N-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5558466.644 m | Easting 17575.896 m | Elevation 1095.375 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
		anthracite coal					
11		CI (till), trace silt, hard, medium-high plasticity, moist, with sub-rounded erratics.				screen	
		moist	AS				
12							
13						$K = 7.4 \times 10^{-10}$ m/s	Frac sand
		Shale, silty, soft. Possibly bedrock.					
14			AS				
		End of Hole @ 14.33 m.					

NOTES:

JOB NO. 2097 BORING NO. N-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097
Boring No. N-P2
Northing 5558468.244 m
Compiled By B.J. Butherford
Location Pine Coulee
Easting 17575.916 m
Boring Date August 19, 1985
Contractor Allkind Drilling
Elevation 1095.364 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. 10 30
LIQUID LIM. 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
		OL, topsoil.	AS			steel casing	
1		CL (till), light brown, some silt, stiff, low-medium plasticity, moist with sub-rounded erratics ≤ 2 cm Ø.				backfill	
		moist					
2						bent. seal	
			AS				
3		GC, sub-rounded erratics, poorly sorted, dirty, ≤ 5 cm Ø.			K = 2.0x10⁻⁶ m/s	Frac sand	
			AS			screen	
4		End of Hole @ 3.66 m.					Dry (Aug 26, 1985)
5							
6							
7							
8							
9							

NOTES:

JOB NO. 2097 BORING NO. N-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097
Boring No. O-P1
Northing 5558428.552 m

Compiled By B.J. Rutherford
Location Pine Coulee
Easting 20655.704 m

Boring Date August 19, 1985
Contractor Alkind Drilling
Elevation 1054.680 m (Ground)

SAMPLE TYPES

AS	Auger sample	TO	Thin wall open
WS	Wash sample	TP	Thin wall piston
RC	Rock core		
CR	CRREL barrel		
SS	Split spoon		

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION: Disturbed; Fair; Good; Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
1		damp — CL, light brown, and silt, low-medium plasticity, loose, homogeneous.	AS			steel casing	
2		damp	AS				
3		GC, dirty, ≤4 cm Ø, CL (as above) intermixed.	AS				
4							
5							
6		CI (till), brown, some silt, medium consistency, medium-low plasticity, with sub-rounded erratics ≤5 cm.	AS				▽ (Aug 27, 1985)
7		damp	AS			backfill	
8							
9		moist					

NOTES:

JOB NO. 2097 BORING NO. O-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097
Boring No. O-P1
Northing 5558428.552 m

Compiled By B.J. Rutherford
Location Pine Coulee
Easting 20655.704 m

Boring Date August 19, 1985
Contractor Allkind Drilling
Elevation 1054.680 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm ⌀ hole) ICE					
		CI (till), brown, as above.	AS				
11		CI (till), grey, some silt, stiff, medium plasticity, with sub-rounded erratics.				backfill	
		very moist	AS				
12						bent seal	
13			AS			Frac sand	
		wet					
14			AS			screen	
		End of Hole @ 14.36 m.					
15							

K = 1.1 x 10⁻⁹ m/s

NOTES:

JOB NO. 2097 BORING NO. O-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 1

Contract No. A85-2097
Boring No. O-P2
Northing 5558428.604 m

Compiled By B.J. Rutherford
Location Pine Coulee
Easting 20656.910 m

Boring Date August 20, 1985
Contractor Allkind Drilling
Elevation 1054.682 m. (Ground)

SAMPLE TYPES

AS	Auger sample	TO	Thin wall open
WS	Wash sample	TP	Thin wall piston
RC	Rock core		
CR	CRREL barrel		
SS	Split spoon		

TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in.
WEATHER

SAMPLE CONDITION: Disturbed; Fair; Good; Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
1		damp CL, light brown, and silt, low-medium plasticity, loose, homogeneous.	AS			steel casing	
2			AS			backfill	
		damp				bent. seal	
3		GC, dirty, ≤ 4 cm Ø. CL (as above) intermixed.	AS			Frac sand	
			AS			screen	
4		End of Hole @ 3.66 m.					Dry (Aug 26, 1985)
5							
6							
7							
8							
9							

K = 3.3 x 10⁻⁶ m/s

NOTES:

JOB NO. 2097. BORING NO. O-P2

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097 | Compiled By B.J. Rutherford | Boring Date August 20, 1985
Boring No. P-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5561649.623 m. | Easting 19208.156 m. | Elevation 1064.692 m. (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
		OL, topsoil.	AS			steel casing	
1		CL (till), light brown, some silt, soft, low plasticity, soft-stiff, with sub-rounded erratics ≤ 4 cm.	AS				
2							
3			AS				
4		damp-moist.	AS				
5						backfill	
6			AS				
7		brown-grey CL, interwoven.	AS				
8							
9		CI (till), grey, some silt, stiff-very stiff, medium plasticity, with sub-rounded erratics ≤ 4 cm Ø.	AS				

NOTES:

JOB NO. 2097 BORING NO. P-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097 | Compiled By B.V. Rutherford | Boring Date August 20, 1985
Boring No. P-P1 | Location Pine Coulee | Contractor Allkind Drilling
Northing 5561649.623 m | Easting 19208.156 m | Elevation 1064.692 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston
TYPE OF RIG 861 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION: Disturbed | Fair | Good | Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. | LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		SSA (152 mm Ø hole) ICE					
11			AS			backfill	
12		moist	AS				
13		CI (till), grey, some silt, stiff-very stiff, medium plasticity, with sub-rounded erratics ≤ 4 cm Ø.					
14			AS			bent. seal	
15		very moist	AS				
16						Frac sand	
17					K = 8.7 x 10⁻⁹ m/s		
18						screen	
						bent. seal	
19		gravel					
			AS			backfill	
		End of Hole @ 19.20 m.					Dry (Aug 27, 1985)

NOTES:

JOB NO. 2077 BORING NO. P-P1

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097
Boring No. Q-P1
Northing 5561698.632 m
Eosting 17569.922 m
Compiled By B.J. Rutherford
Location Pine Coulee
Boring Date August 22, 1985
Contractor Alkind Drilling
Elevation 1043.790 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

SSA (152 mm Ø hole) ICE

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION	Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
0		damp	AS			steel casing	
			AS				
1		very moist	AS			bent. seal	
2		CH, brown-grey, little silt, medium consistency, medium-high plasticity.			K= 9.6x10⁻¹² m/s	Frac sand	screen
		wet	AS			bent. seal	
3							
4						backfill	
5							
6		silt laminae	AS				
7		CI, grey, little silt, stiff, medium plasticity with layers ≤ 1.5 m of soft, grey shale.					
8			AS				
9		soft shale and CI.					

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Contract No. A85-1097
Boring No. Q-P1
Northing 5561698.632 m

Compiled By B.J. Rutherford
Location Pine Coulee
Easting 17569.922 m

Boring Date August 22, 1985
Contractor Allkind Drilling
Elevation 1043.790 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION (SSA (152 mm Ø hole) ICE)	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		wet	AS				
		CI, grey, little silt, stiff, medium plasticity with layers ≤ 1.5 m of soft, grey shale.					
11		soft shale and layers (2.5-5.0cm) of CI.				backfill	
			AS				
12		End of Hole @ 11.89 m.					Dry (Aug 26, 1985)

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 1 of 2

Contract No. A85-2097
Boring No. Q-P2
Northing 5561700.820 m

Compiled By B.J. Rutherford
Location Pine Coulee
Easting 17569.856 m

Boring Date August 23, 1985
Contractor Allkind Drilling
Elevation 1043.717 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61-Truck Mounted
SAMPLE HAMMER: wt. 140 lb. drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER kN/m²
□ UNCONFINED COMP STR kN/m²
△ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION HSA (203 mm Ø hole) and SSA (152 mm Ø hole) ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
0		damp	AS			steel casing	
1		very moist	AS				(Aug 27, 1985)
2		CH, brown-grey, little silt, medium consistency, medium - high plasticity.					
3		wet	AS			backfill	
4							
5							
6		silt laminae 1 mm thick.	AS			bent seal	
7						screen	
8		CI, grey, little silt, stiff, medium plasticity with layers ≤ 1.5 m of soft, grey shale.			$K = 1.0 \times 10^{-5}$ m/s	Frac sand	
9		soft shale and CI	AS			bent seal backfill	

NOTES:

PITEAU ENGINEERING LTD.
GEOTECHNICAL CONSULTANTS

OFFICE REPORT ON SITE INVESTIGATION

Sheet 2 of 2

Contract No. A85-2097
Boring No. Q-P2
Northing 5561700.820 m

Compiled By B.J. Rutherford
Location Pine Coulee
Easting 17569.856 m

Boring Date August 23, 1985
Contractor Allkind Drilling
Elevation 1043.717 m (Ground)

SAMPLE TYPES
AS Auger sample
WS Wash sample
RC Rock core
CR CRREL barrel
SS Split spoon
TO Thin wall open
TP Thin wall piston

TYPE OF RIG B61 - truck mounted
SAMPLE HAMMER: wt. 140 lb drop 30 in
WEATHER

SAMPLE CONDITION
Disturbed
Fair
Good
Lost

TEST INFORMATION
● PENETROMETER KN/m²
□ UNCONFINED COMP STR KN/m²
Δ SPT N-VALUE BLOWS/0.3m
WATER CONTENT %
PLASTIC LIM. ⊙ LIQUID LIM.
10 30 50 70 90

Depth (m)	Symbol	SOIL/ROCK DESCRIPTION HSA (203 mm Ø hole) and SSA (152 mm Ø hole) ICE	SAMPLES Type	Condition	Number	OTHER TESTS	PIEZOMETER DETAILS
		wet					
11		soft shale and layers (2.5 - 5.0cm) of CI.					
12			AS				
13		CI, grey, little silt, hard, medium plasticity with layers ≤ 2 m of soft-medium hardness, grey (-green) shale and siltstone.(interbedded with CI).					
14						backfill	
15			AS				
16		medium hardness shale and silt-stone.					
17							
18			AS				
19		medium hardness shale with layers (2.5 - 5.0cm) of CI.	AS				
		End of Hole @ 19.5 m.					

NOTES:

JOB NO. 2097 BORING NO. Q-P2

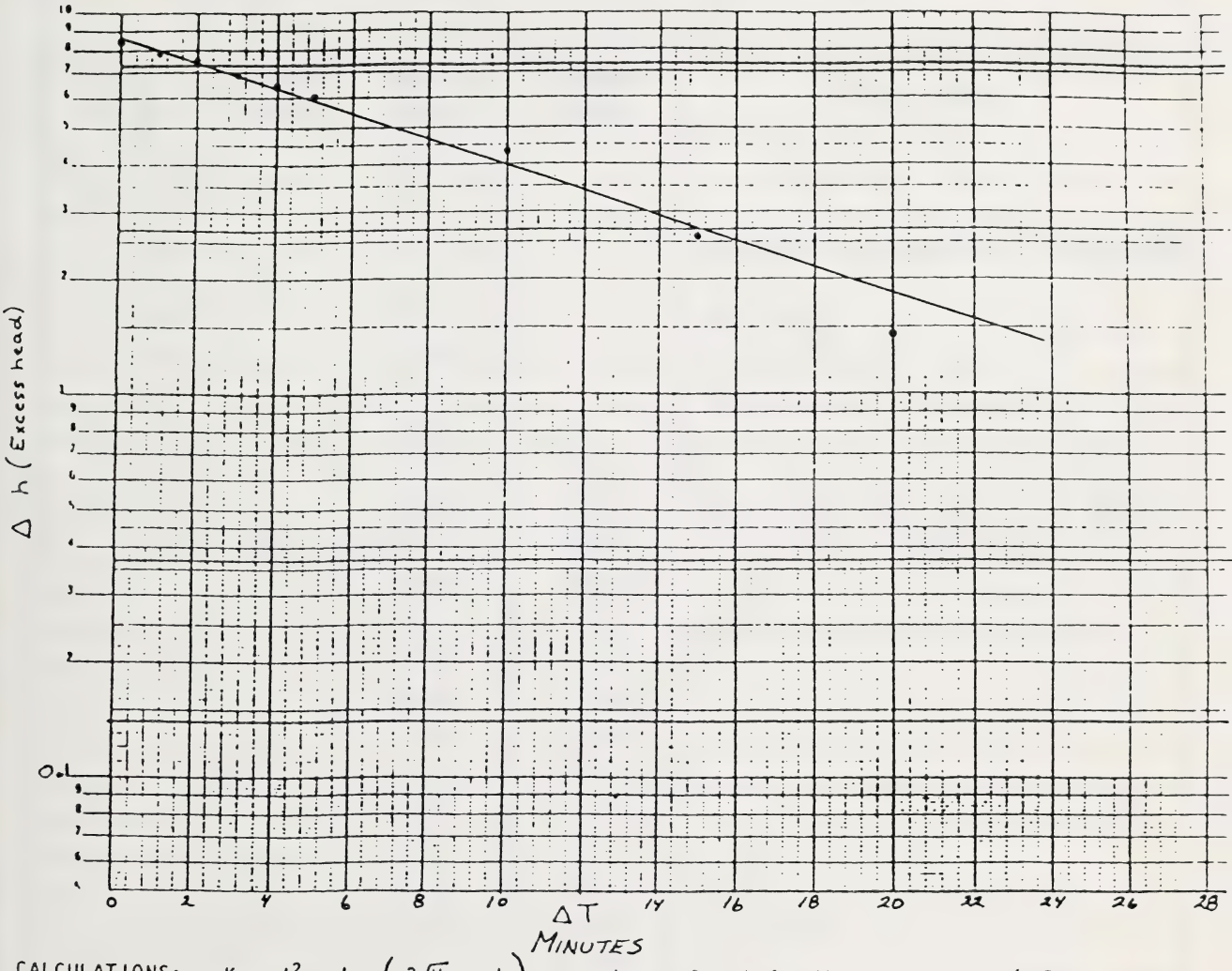
WATER LEVEL MEASUREMENTS AND HYDRAULIC CONDUCTIVITY TESTS

(Measurements Relative to Top of PVC Pipe)

PA-6 Permeability Test Sheet for Test No A P-1 (Bail Test) Sheet 1 of 2

Test Interval 17.53 to 20.57 (metres)

57.5 to 67.5 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

where: D = Hole diameter 20.3 cm (8 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 305 cm (120 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 765 seconds

$K = \frac{5.25^2}{8 \times 305 \times 765} \ln\left(\frac{2\sqrt{1}}{20.3} \times 305\right)$

$K = 5.0 \times 10^{-5}$ cm/sec

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

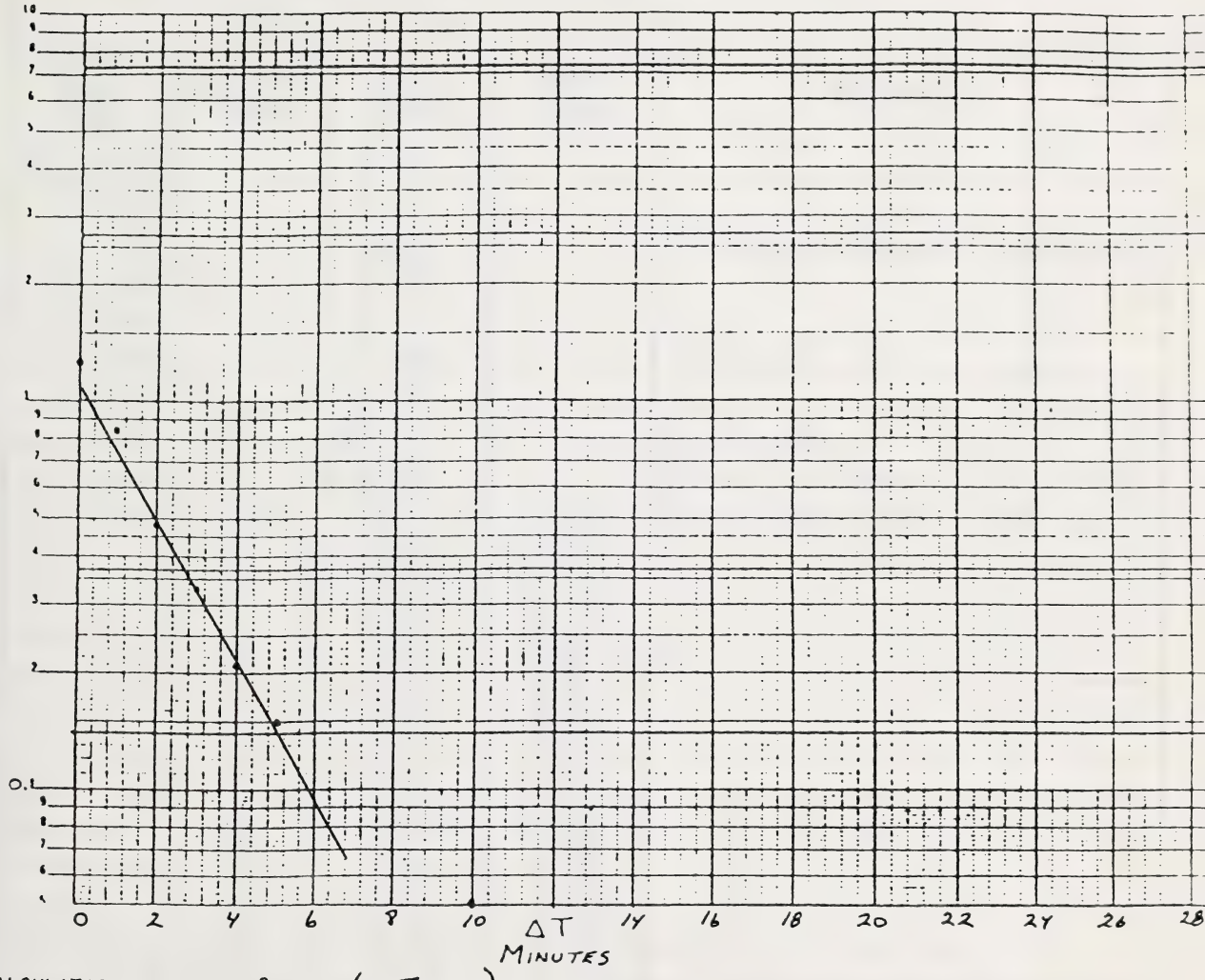
Pine Coulee (A-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 14:00		5.86 m		
24 09:46		5.89		
10:20		13.62		Developed piezometer ⇒ dirty water
10:32		11.33		
10:49		15.75		Developed
11:16		16.56		Developed
14:24		17.05		Developed
25 09:10		5.59		
11:36		13.75		
29 09:40		5.60		Datum (for hydraulic cond. test)
10:00	0 min	14.05	8.45 m	Rising Head (Bail) Test.
	1	13.47	7.87	
	2	13.01	7.41	
	3	12.48	6.88	
	4	12.05	6.45	
	5	11.60	6.00	
	10	9.63	4.03	
	15	8.17	2.57	
	20	7.05	1.45	
	30	5.78	0.18	
	50	5.63	0.03	
	70	5.63	0.03	
	85	5.63	0.03	
14:55	295	5.62	0.02	
	375	5.61	0.01	
30 08:55	1375	5.60	0.00	

PA-6 Permeability Test Sheet for Test No A P-2 (Bail Test) Sheet 1 of 2

Test Interval 13.56 to 15.09 (metres)

44.5 to 49.5 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

where: D = Hole diameter 20.3 cm (8 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 146 seconds

$$K = \frac{5.25^2}{8 \times 152 \times 146} \ln\left(\frac{2\sqrt{1}}{20.3} \times 152\right)$$

$$K = 4.2 \times 10^{-4} \text{ cm/sec}$$

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

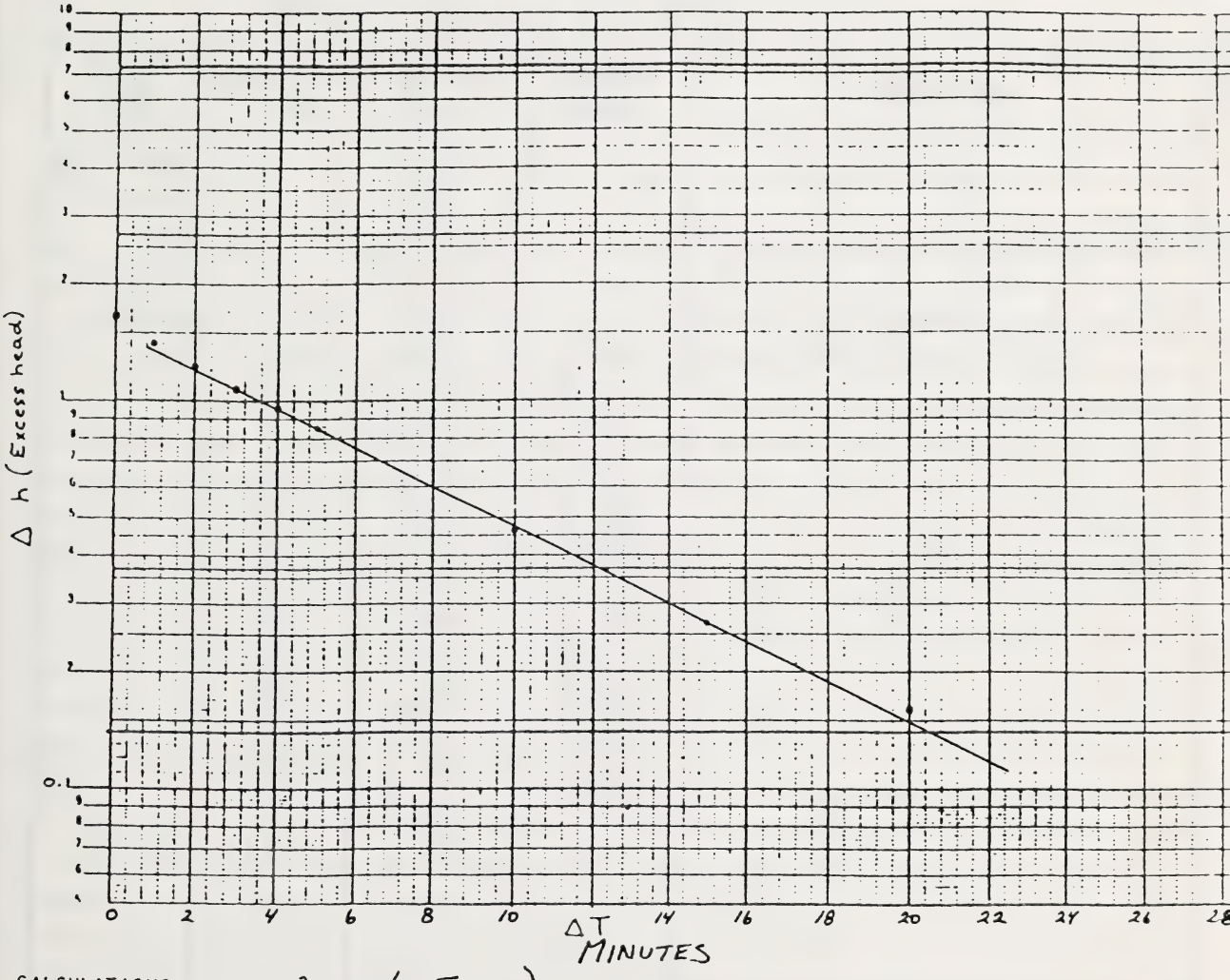
Pine Coulee (A-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 14:02		6.20 m		
24 9:47		6.20		
10:30		9.53		Developed piezometer ⇒ dirty water
10:43		6.50		
10:49		6.47		
14:28		10.34		Developed
25 9:15		6.20		
11:21		10.20		Developed
29 9:40		6.20		Datum (for hydraulic cond. test)
10:25	0 min	7.47	1.27 m	Rising Head (Bail) Test.
	1	7.03	0.83	
	2	6.68	0.48	
	3	6.53	0.33	
	4	6.41	0.21	
	5	6.35	0.15	
	10	6.25	0.05	
	15	6.24	0.04	
	20	6.23	0.03	
	30	6.23	0.03	
	35	6.23	0.03	
	60	6.23	0.03	
	270	6.22	0.02	
	350	6.21	0.01	
30 8:55	1350	6.20	0.00	

PA-6 Permeability Test Sheet for Test No A P-3 (Bail Test) Sheet 1 of 2

Test Interval 5.79 to 6.71 (metres)

19 to 22 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 514} \ln\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$

$K = 1.3 \times 10^{-4}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 514 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

Pine Coulee (A-P3)

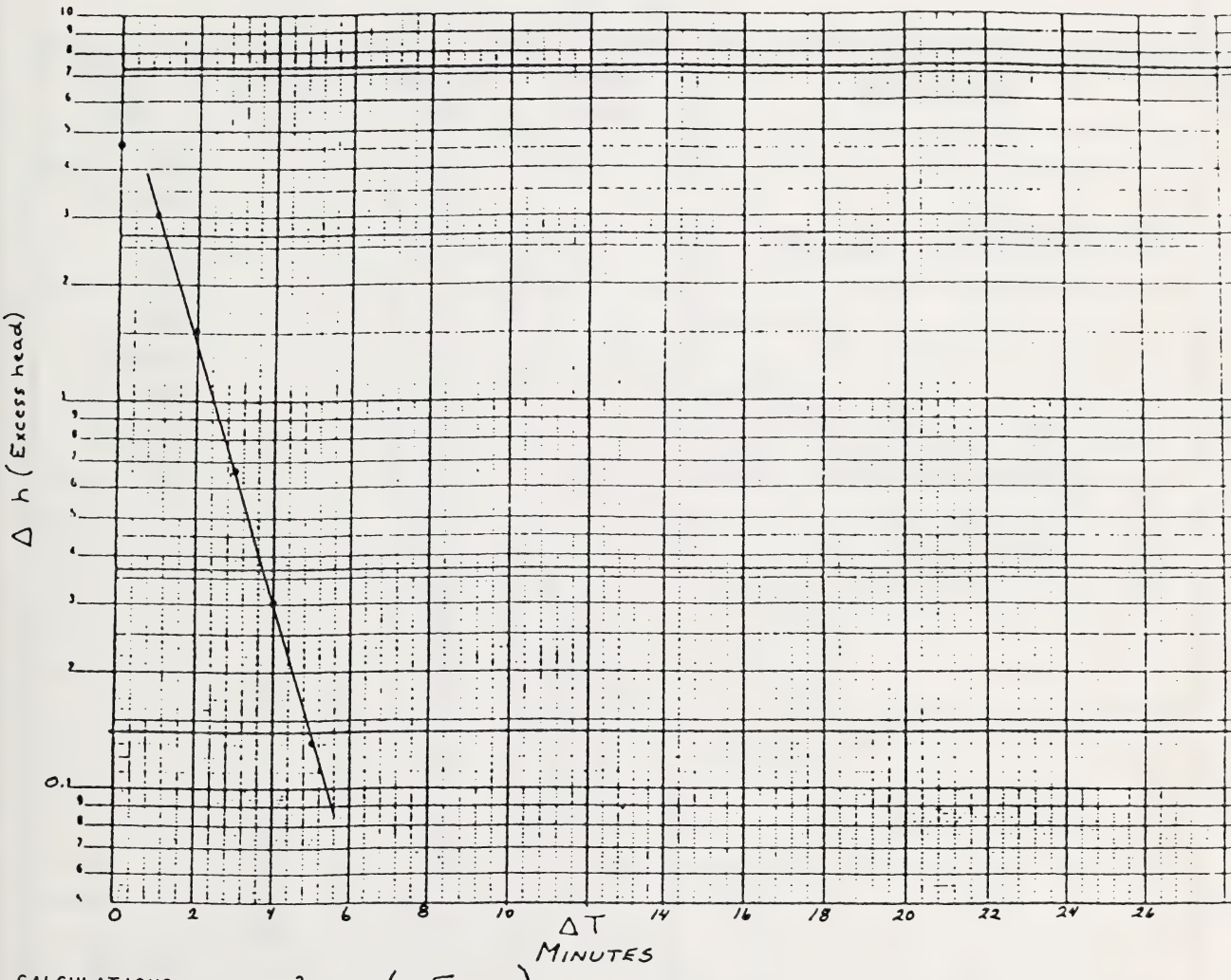
DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 14:10		5.27m		
24 9:50		5.27		
10:00		5.87		Developed piezometer ⇒ dirty water
25 9:16		5.27		
29 9:40		5.27		Datum (for hydraulic cond. test).
11:00	0min	6.94	1.67m	Rising Head (Bail) Test.
	1	6.67	1.40	
	2	6.50	1.23	
	3	6.36	1.09	
	4	6.23	0.96	
	5	6.13	0.86	
	10	5.74	0.47	
	15	5.54	0.27	
	20	5.43	0.16	
	30	5.33	0.06	
	40	5.29	0.02	
	235	5.27	0.00	
	315	5.26	—	
30 9:00	1320	5.26	—	

PA-6 Permeability Test Sheet for Test No B P-1 Sheet 1 of 2

(Bail Test)

Test Interval 14.33 to 17.37 (metres)

47 to 57 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

where: D = Hole diameter 20.3cm (8 in)

d = Tube diameter 5.25cm (2.067in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 305cm (120 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

$K = \frac{5.25^2}{8 \times 305 \times 78} \ln\left(\frac{2\sqrt{1}}{20.3} \times 305\right)$

78 seconds

$K = 4.9 \times 10^{-4}$ cm/sec

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

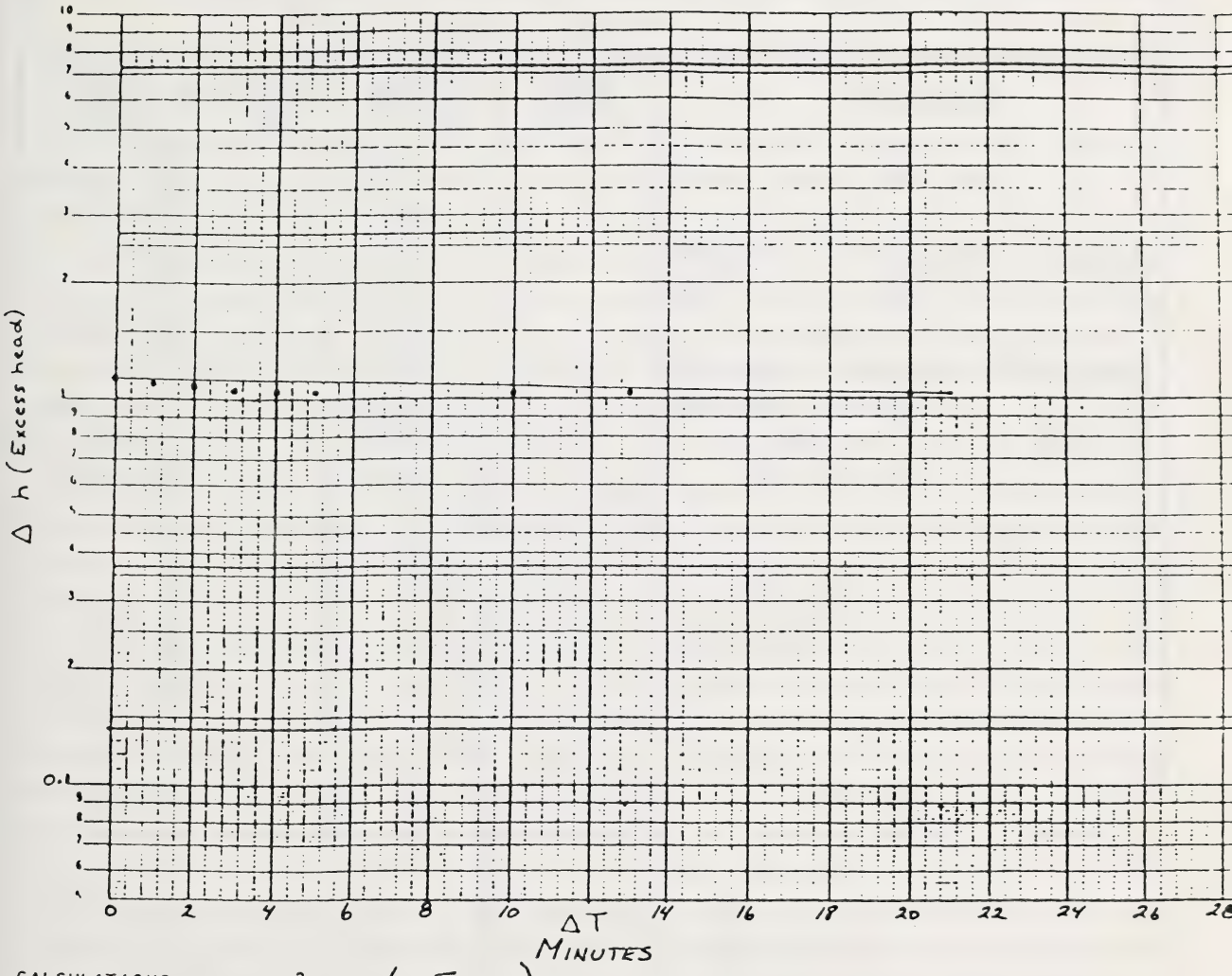
Pine Coulee (B-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 14:26		6.66m		
24 11:41		6.65		
11:48		12.01		Developed piezometer ⇒ dirty water
11:53		10.20		
12:00		10.21		Developed
25 10:30		6.64		
11:08		10.23		Developed
29 12:30		6.66		Datum (for hydraulic cond. test)
12:45	0 min	11.28	4.62 m	Rising Head (Bail) Test.
	1	9.67	3.01	
	2	8.17	1.51	
	3	7.33	0.67	
	4	6.96	0.30	
	5	6.79	0.13	
	10	6.72	0.06	
	15	6.70	0.04	
	20	6.69	0.03	
	30	6.69	0.03	
	50	6.68	0.02	
	120	6.67	0.01	
	200	6.66	0.00	
30 8:40	1195	6.63	—	

PA-6 Permeability Test Sheet for Test No B P-2 (Bail Test) Sheet 1 of 2

Test Interval 4.57 to 7.62 (metres)

15 to 25 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 305 \times 222,147} \ln\left(\frac{2\sqrt{1}}{15.2} \times 305\right)$

$K = 1.9 \times 10^{-7}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 305 cm (120 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 222,147 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

Pine Coulee (C-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 14:17		5.89 m		Clean water at top.
24 13:30		5.89		
13:35		6.20		Attempted to develop with N_2 purge
14:13		6.55		Developed piezometer ⇒ dirty water
25 10:10		6.55		
10:25		6.55		Attempted to develop ⇒ insufficient water
29 11:50		6.55		Attempted to develop
12:00		5.93		⇒ piezometer is not functional
30 08:35		5.93		due to clay

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

Pine Coulee (B-P2)

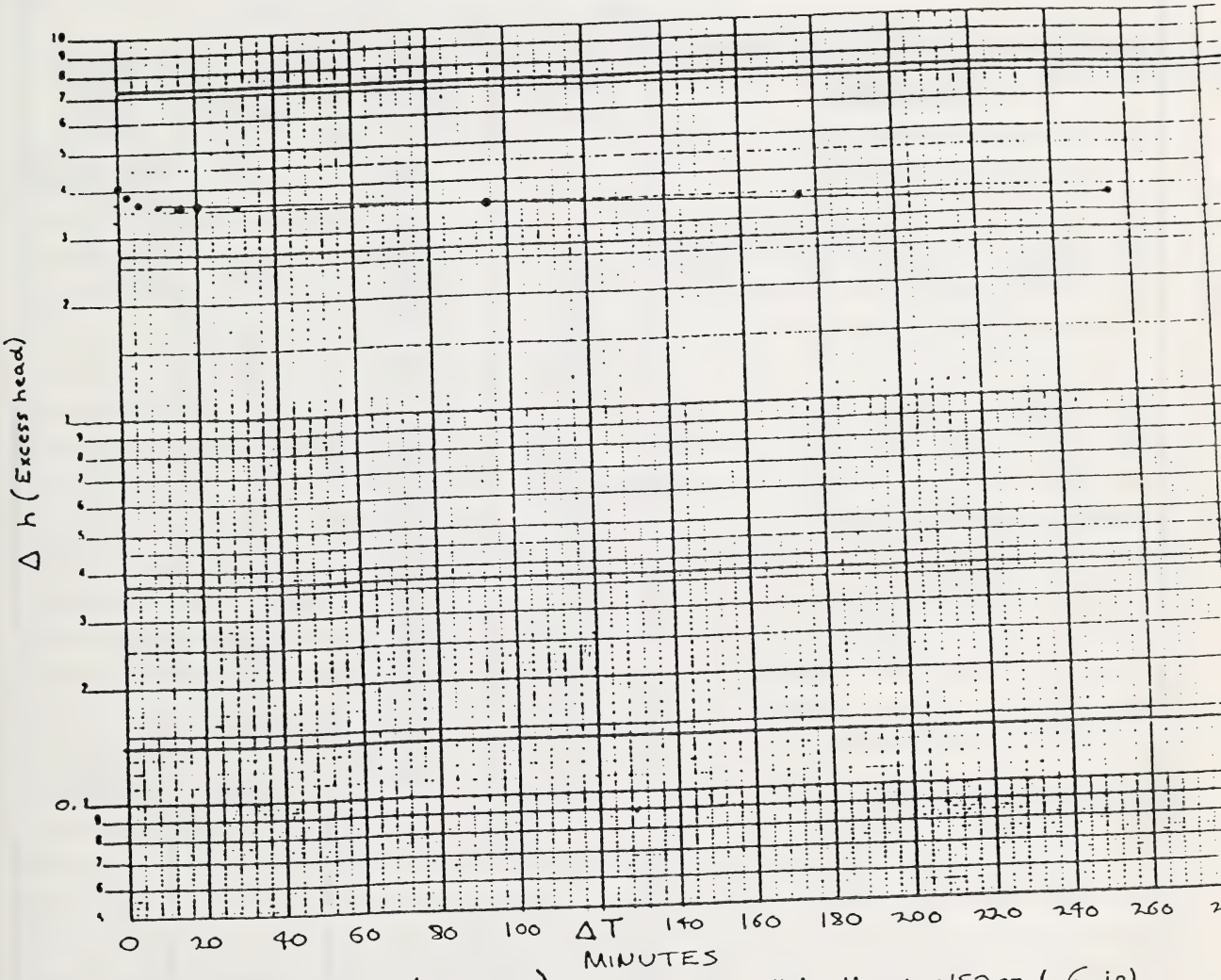
DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 14:30		6.19m		
24 11:42		6.19		
11:51		—		Attempted to develop with N_2 purge
25 10:29		6.18		⇒ developed by bailing
29 12:30		6.19		Datum (for hydraulic cond. test).
13:05	0 min	7.33	1.14m	Rising Head (Bail) Test.
	1	7.30	1.11	⇒ bailed out clean water
	2	7.27	1.08	
	3	7.26	1.07	
	4	7.26	1.07	
	5	7.25	1.06	
	10	7.25	1.06	
	15	7.24	1.05	
	20	7.23	1.04	
	30	7.22	1.03	
	100	7.19	1.00	
	180	7.17	0.98	
30 8:40	1175	7.02	0.83	

PA-6

Permeability Test Sheet for Test No C P-2 (Slug Test)

Test Interval 3.96 to 5.49 (metres)

13 to 18 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 102{,}900} \ln\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$

$K = 6.6 \times 10^{-7}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Lin

= 102,900 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

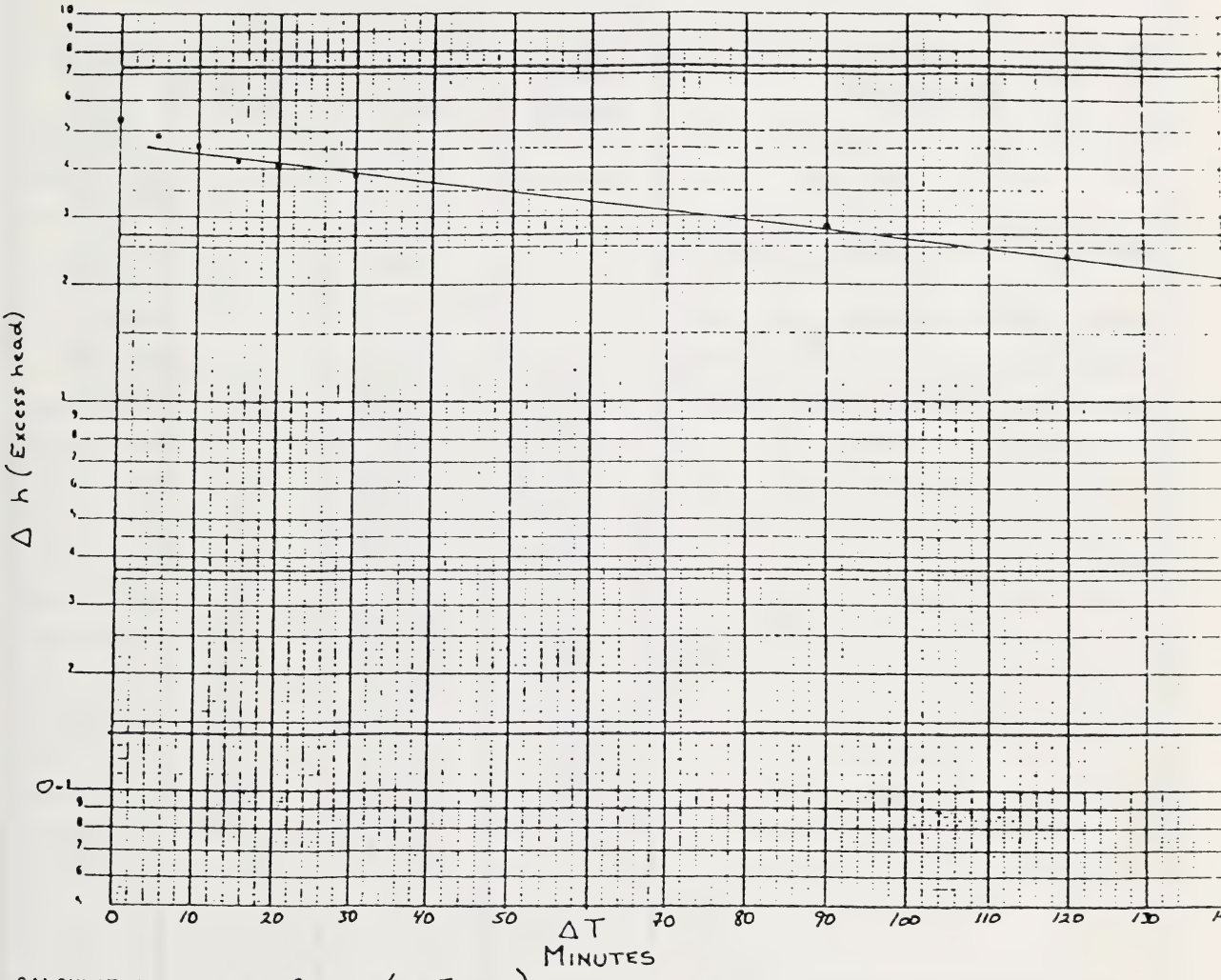
Pine Coulee (C-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 14:20		Dry		
24 13:25		Dry		
29 11:50		Dry		Datum = 5.89 m
11:55	0 min	1.84 m	4.05 m	Falling Head (Slug) Test
	1	1.99	3.92	
	2	2.05	3.84	
	3	2.11	3.78	
	4	2.16	3.73	
	5	2.18	3.71	
	10	2.25	3.64	
	15	2.27	3.62	
	20	2.28	3.61	
	30	2.30	3.59	
	95	2.39	3.50	
	175	2.50	3.39	
	255	2.58	3.31	
30 8:35	1240	3.16	2.73	

PA-6 Permeability Test Sheet for Test No D P-1 (Bail Test) Sheet 1 of 2

Test Interval 10.21 to 11.73 (metres)

33.5 to 38.5 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

where: D = Hole diameter 20.3 cm (8 in)

d = Tube diameter 5.25 cm (2.007 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

$K = \frac{(5.25)^2}{8 \times 152 \times 9{,}105} \ln\left(\frac{2\sqrt{1}}{20.3} \times 152\right)$

$K = 6.7 \times 10^{-6}$ cm/sec

9,105 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

Pine Coulee (D-P1)

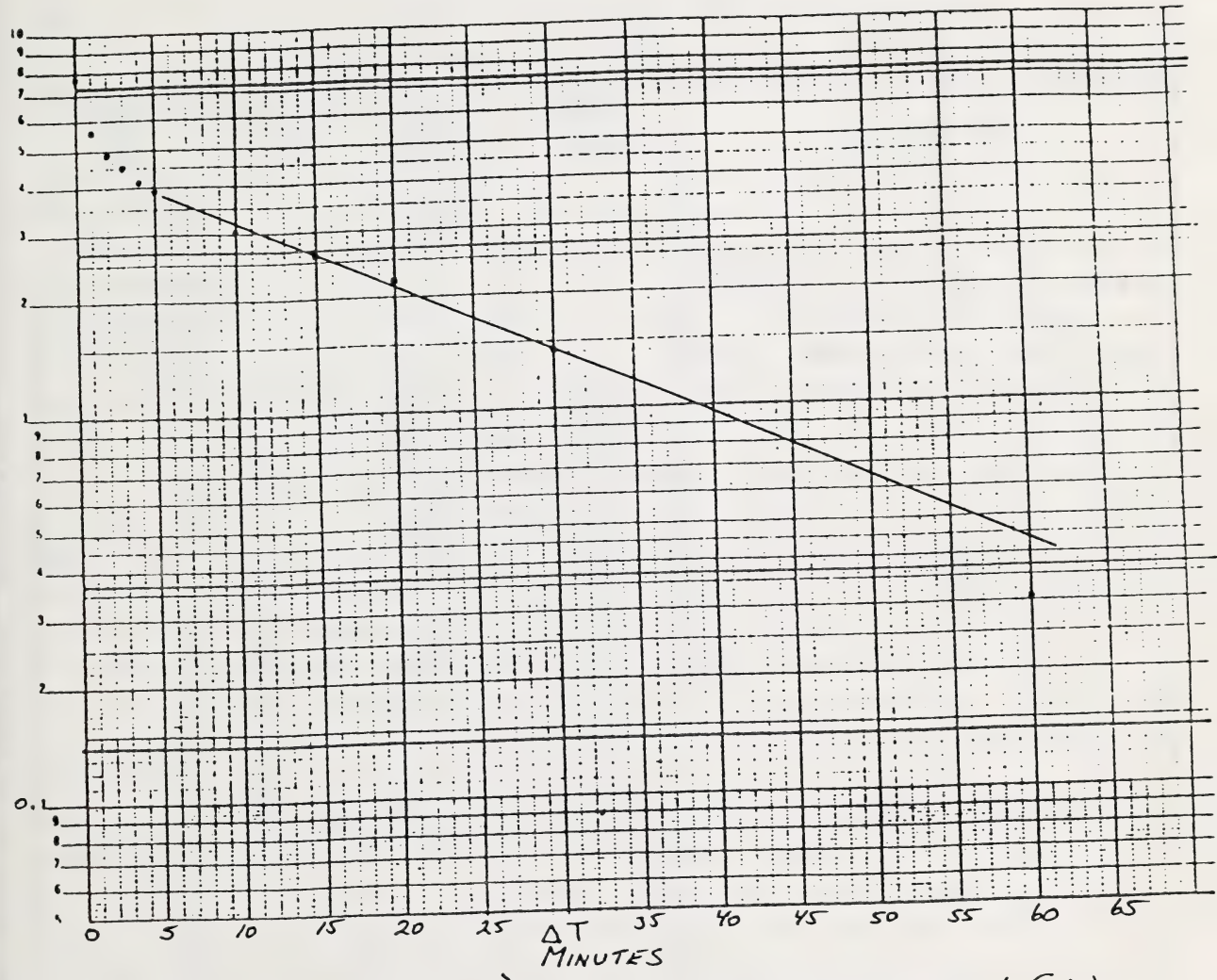
DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 14:38		6.31m		
24 13:50		6.32		
14:00		7.04		Developed piezometer ⇒ clean water
25 10:46		7.02		
10:52		8.51		Developed piezometer ⇒ dirty water
29 13:40		6.35		Datum (for hydraulic cond. test)
14:00	0min	11.62	5.27m	Rising Head (Bail) Test.
	1	11.57	5.22	
	2	11.48	5.13	
	3	11.40	5.05	
	4	11.34	4.99	
	5	11.26	4.91	
	10	10.90	4.55	
	15	10.64	4.29	
	20	10.53	4.18	
	30	10.27	3.92	
	90	9.19	2.84	
	120	8.74	2.39	
30 8:45	1125	6.27	——	

PA-6

Permeability Test Sheet for Test No D P-2 (Bail Test)

Test Interval 5.79 to 7.32 (metres)

19 to 24 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \; Ln\left(\frac{2\sqrt{M}}{D} \times L\right)$

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

M = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 900 seconds

$$K = \frac{5.25^2}{8 \times 152 \times 900} \; Ln\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$$

$$K = 7.5 \times 10^{-5} \text{ cm/sec}$$

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

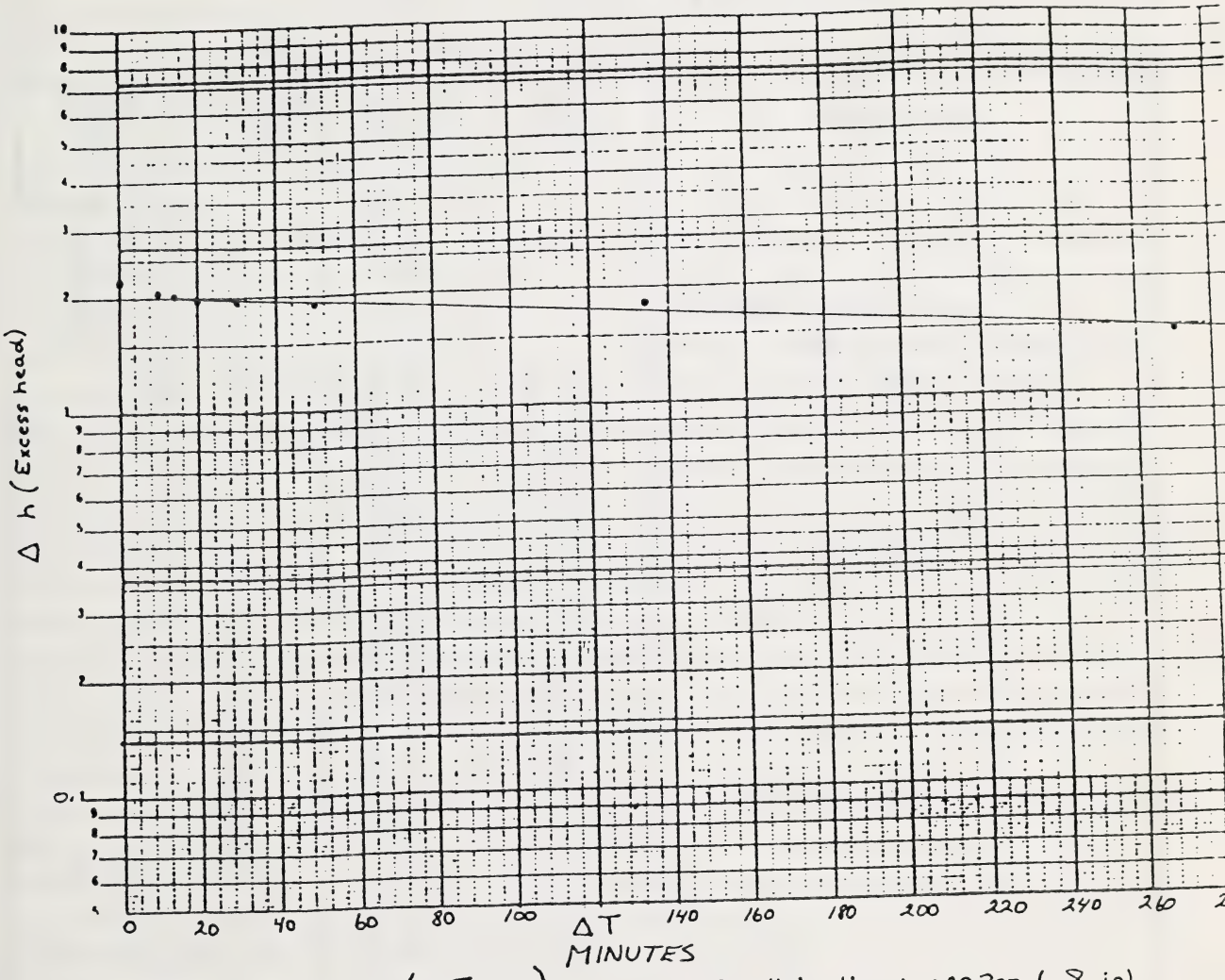
Pine Coulee (D-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 14:40		6.20m		
24 13:55		6.19		
14:15		—		Attempted to develop with N2 purge ⇒ developed by bailing
25 10:48		6.19		
29 13:45		6.17		Datum (for hydraulic cond. test)
14:25	0 min	6.95	0.78 m	Rising Head (Bail) Test.
	1	6.73	0.56	
	2	6.66	0.49	
	3	6.62	0.45	
	4	6.58	0.41	
	5	6.56	0.39	
	10	6.47	0.30	
	15	6.43	0.26	
	20	6.39	0.22	
	30	6.31	0.14	
	60	6.20	0.03	
	95	6.19	0.02	
30 8:45	1100	6.18	0.01	

PA-6 Permeability Test Sheet for Test No F P-1 (Bail Test) Sheet 1 of 2

Test Interval 5.18 to 6.71 (metres)

17 to 22 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \text{Ln}\left(\frac{2\sqrt{H}}{D} \times L\right)$

where: D = Hole diameter 20.3 cm (8 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 32,416 seconds

$$K = \frac{5.25^2}{8 \times 152 \times 32{,}416} \text{Ln}\left(\frac{2\sqrt{1}}{20.3} \times 152\right)$$

$$K = 1.9 \times 10^{-6} \text{ cm/sec}$$

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

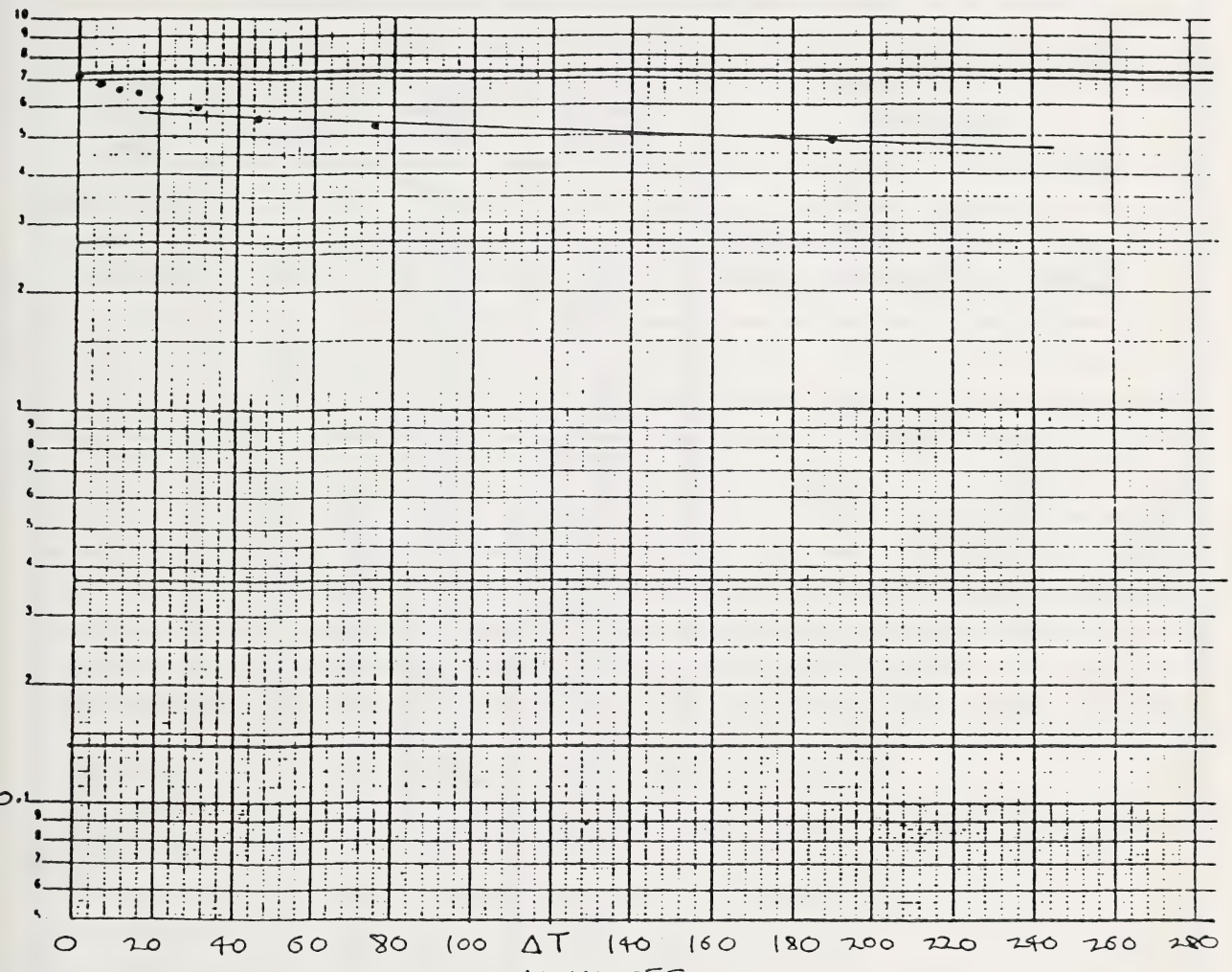
Pine Coulee (F-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 12:16		4.03m		
24 9:19		4.01		
26 18:00		4.02		
26 18:15		6.13		Developed pierometer.
28 12:25		4.03		Datum (for hydraulic cond. test)
12:35	0 min	6.15	2.12m	Rising Head (Bail) Test.
	1	6.13	2.10	
	2	6.11	2.08	
	3	6.10	2.07	
	4	6.09	2.06	
	5	6.08	2.05	
	10	6.06	2.03	
	15	6.04	2.01	
	20	6.02	1.99	
	30	6.00	1.97	
	50	5.95	1.92	
	135	5.83	1.80	
	270	5.51	1.48	
29 8:35	1200	4.26	0.23	
16:30	1685	4.11	0.08	
30 8:20	2625	4.06	0.03	

PA-6 Permeability Test Sheet for Test No G P-1 (Slug Test) Sheet 1 of 2

Test Interval 6.10 to 7.62 (metres)

20 to 25 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 63{,}969} \ln\left(\frac{2\sqrt{1}}{20.3} \times 152\right)$

$K = 9.6 \times 10^{-7}$ cm/sec

where: D = Hole diameter 20.3 cm (8 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 63,969 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

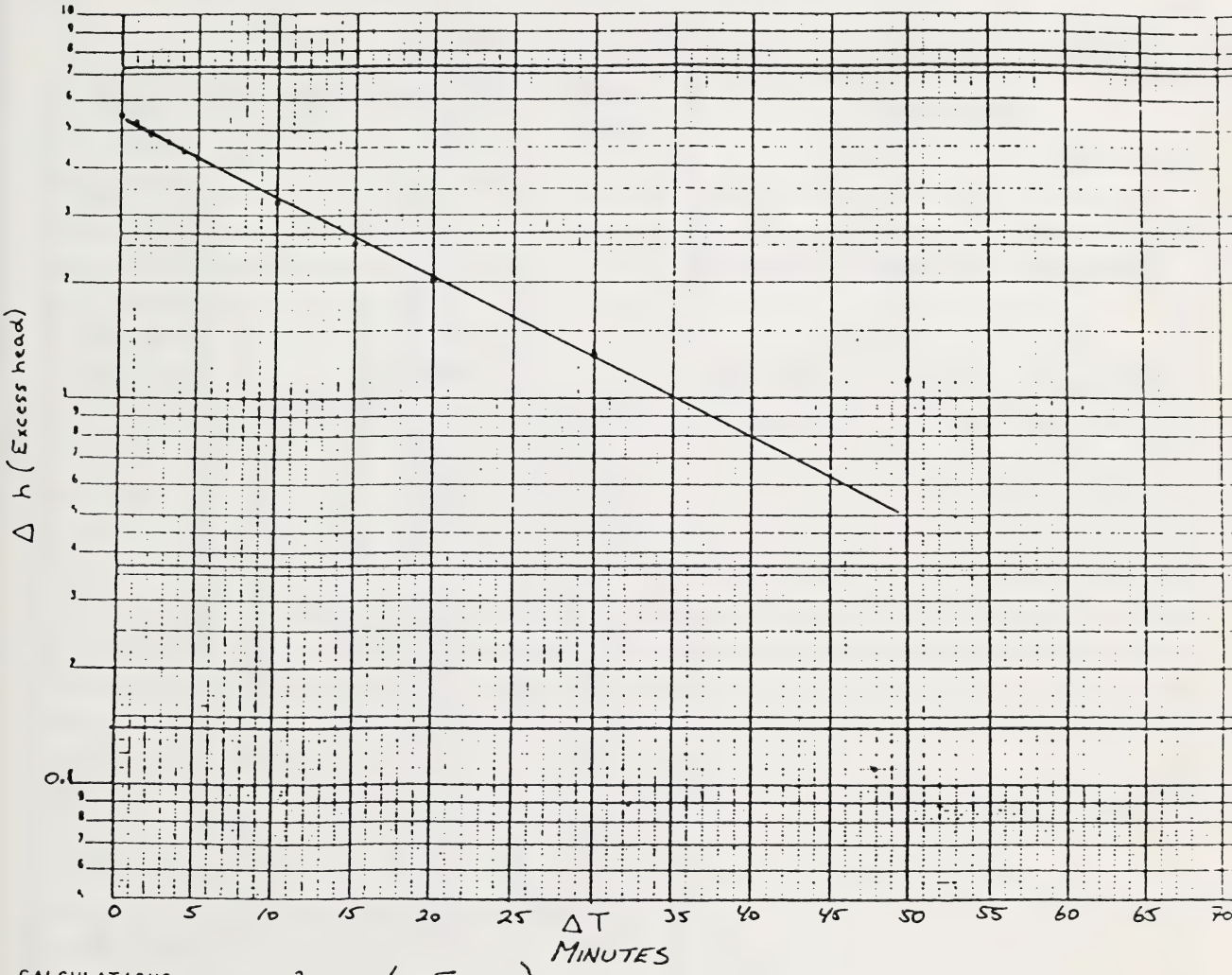
Pine Coulee (G-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 11:31		Dry		
24 16:30		Dry		Datum = 8.05m
28 13:45	0min	0.93m	7.12m	Falling Head (Slug Test)
	1	1.10	6.95	
	2	1.12	6.93	
	3	1.14	6.91	
	4	1.18	6.87	
	5	1.23	6.82	
	10	1.44	6.61	
	15	1.62	6.43	
	20	1.80	6.25	
	30	2.14	5.91	
	45	2.47	5.58	
	75	2.70	5.35	
	190	3.13	4.92	
29 8:45	1140	3.72	4.33	
16:45	1620	3.95	4.10	
30 9:20	2435	4.37	3.68	

PA-6 Permeability Test Sheet for Test No GP-2 (Bail Test) Sheet 1 of 2

Test Interval 26.97 to 30.02 (metres)

88.5 to 98.5 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$$K = \frac{5.25^2}{8 \times 305 \times 1230} \ln\left(\frac{2\sqrt{1}}{15.2} \times 305\right)$$

$$K = 3.4 \times 10^{-5} \text{ cm/sec}$$

where: D = Hole diameter 15.2cm (6 in)

d = Tube diameter 5.25m (2.067in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 305 cm (120 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 1230 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

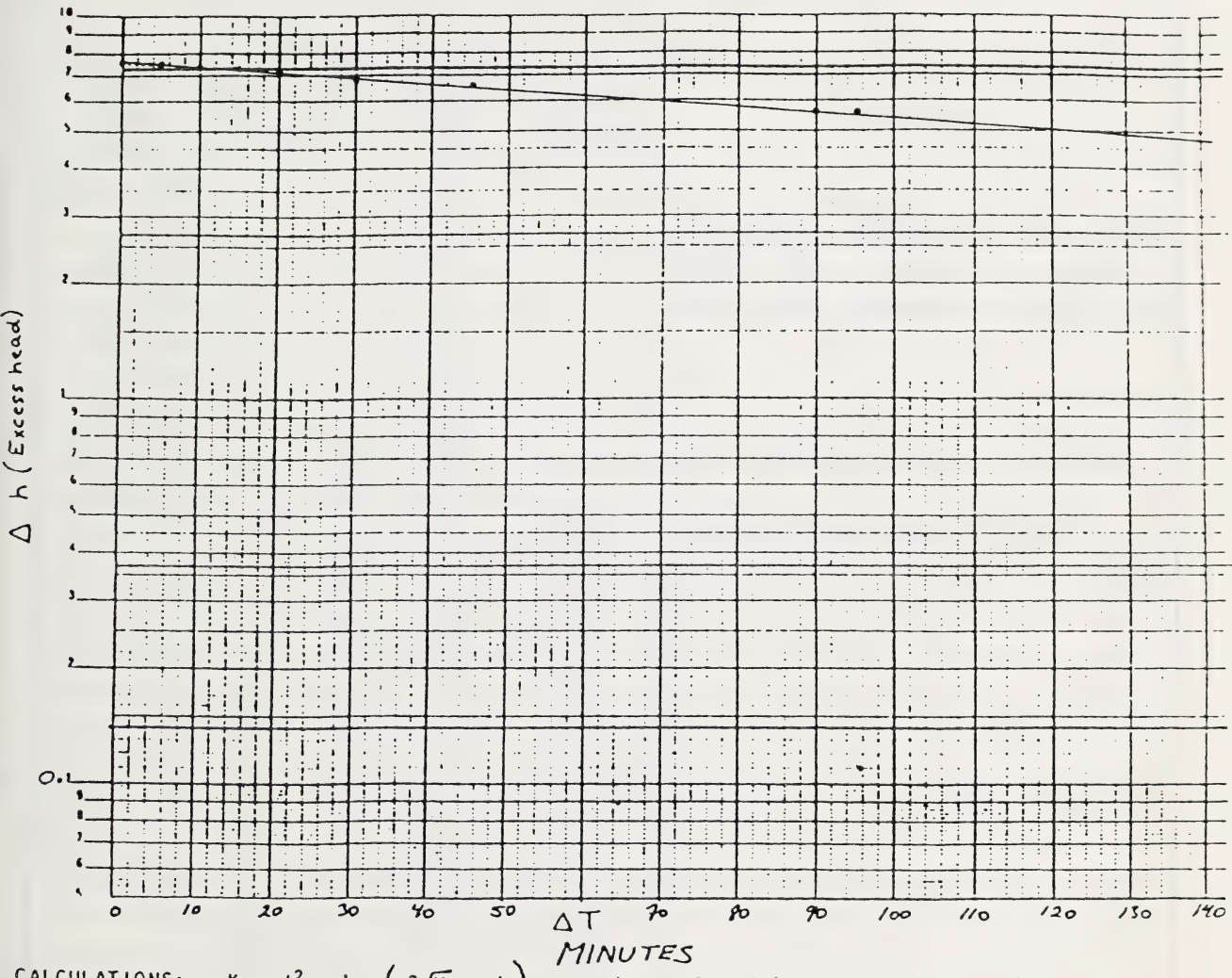
Pine Coulee (G-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 11:35		12.60m		
24 16:30		12.34		
16:50		19.85		Developed piezometer ⇒ clean water
25 16:45		12.47		
26 18:00		12.66		
28 13:35		12.66		Datum (for hydraulic cond. test)
14:10	0 min	18.14	5.48 m	Rising Head (Bail) Test
	1	17.82	5.16	
	2	17.54	4.88	
	3	17.29	4.63	
	4	17.07	4.41	
	5	16.84	4.18	
	10	15.89	3.23	
	15	15.16	2.50	
	20	14.68	2.02	
	30	14.00	1.34	
	50	13.78	1.12	
	165	12.95	0.29	
29 8:40	1110	12.67	0.01	
16:45	1595	12.66	0.00	
30 9:25	2595	12.66	0.00	

PA-6 Permeability Test Sheet for Test No H P-1 (Bail Test) Sheet 1 or 2

Test Interval 10.36 to 13.41 (metres)

34 to 44 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 305 \times 20{,}357} \ln\left(\frac{2\sqrt{1}}{20.3} \times 305\right)$

$K = 1.9 \times 10^{-6}$ cm/sec

where: D = Hole diameter 20.3 cm (8 in)

d = Tube diameter 5.25 m (2.067 in)

H = K_H / K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 305 cm (120 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 20,357 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

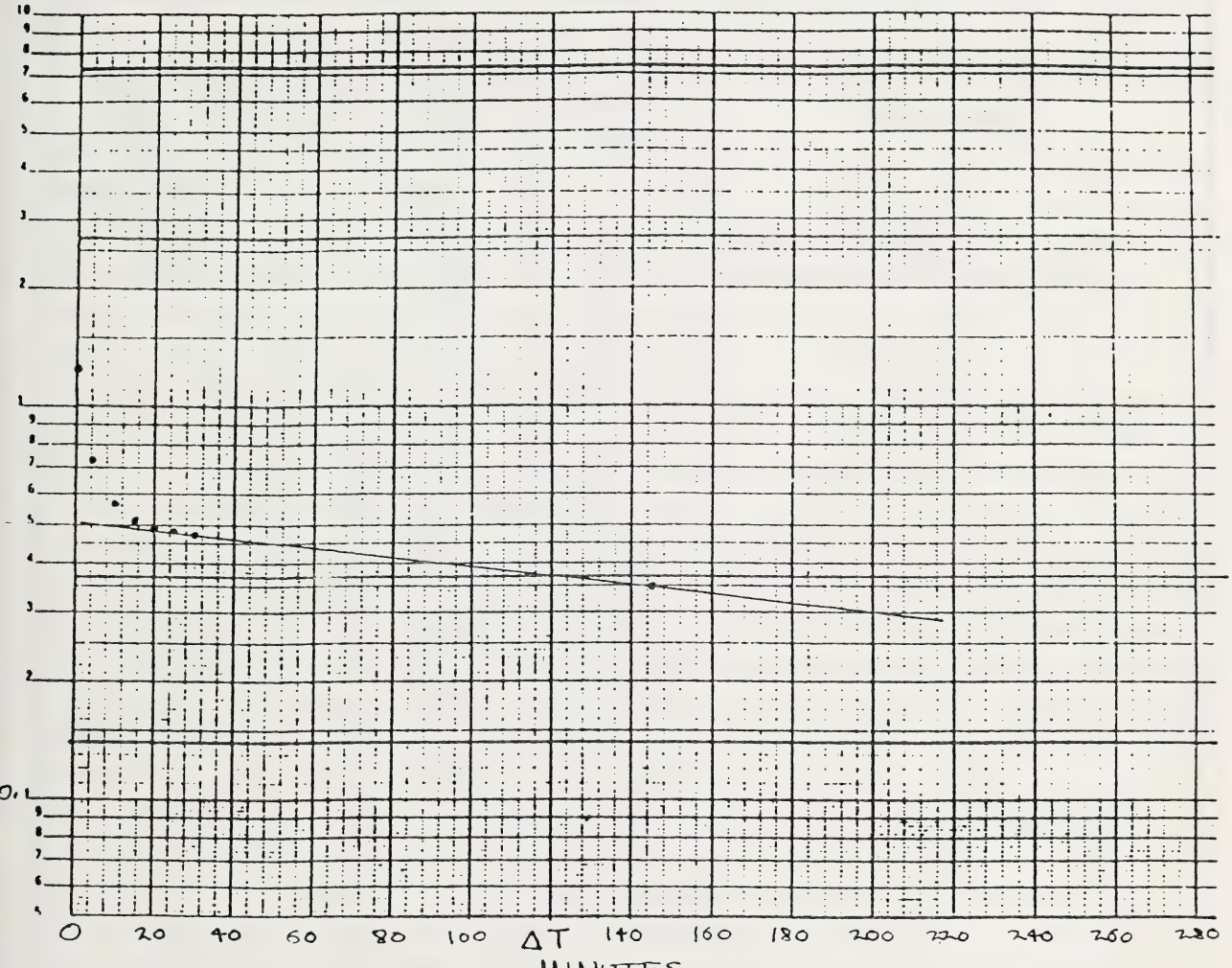
Pine Coulee (H-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 11:46		4.13m		
17:20		10.12		Developed piezometer ⇒ clean water
25 14:05		4.14		Datum (for hydraulic cond. test)
14:46		9.85		Developed piezometer with N_2 purge
26 9:32		4.51		
17:00		4.30		
27 17:50		4.15		
18:15		11.65		Developed piezometer by bailing
28 11:15		4.70		
11:35	0 min	11.75	7.61m	Rising Head (Bail) Test
	1	11.72	7.58	
	2	11.71	7.57	
	3	11.70	7.56	
	4	11.69	7.55	
	5	11.67	7.53	
	10	11.55	7.41	
	15	11.37	7.23	
	20	11.26	7.12	
	30	11.05	6.91	
	45	10.85	6.71	
	95	9.76	5.62	
	190	8.32	4.18	
	325	7.06	2.92	
29 8:40	1265	4.57	0.43	
16:35	1740	4.31	0.17	
30 9:15	2740	4.14	0.00	

PA-6 Permeability Test Sheet for Test No H P-2 (Slug Test) Sheet 1 of 2

Test Interval 2.44 to 3.96 (metres)

8 to 13 (feet)



LCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 21,982 seconds

$$K = \frac{5.25^2}{8 \times 152 \times 21{,}982} \ln\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$$

$$K = 3.1 \times 10^{-6} \text{ cm/sec}$$

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

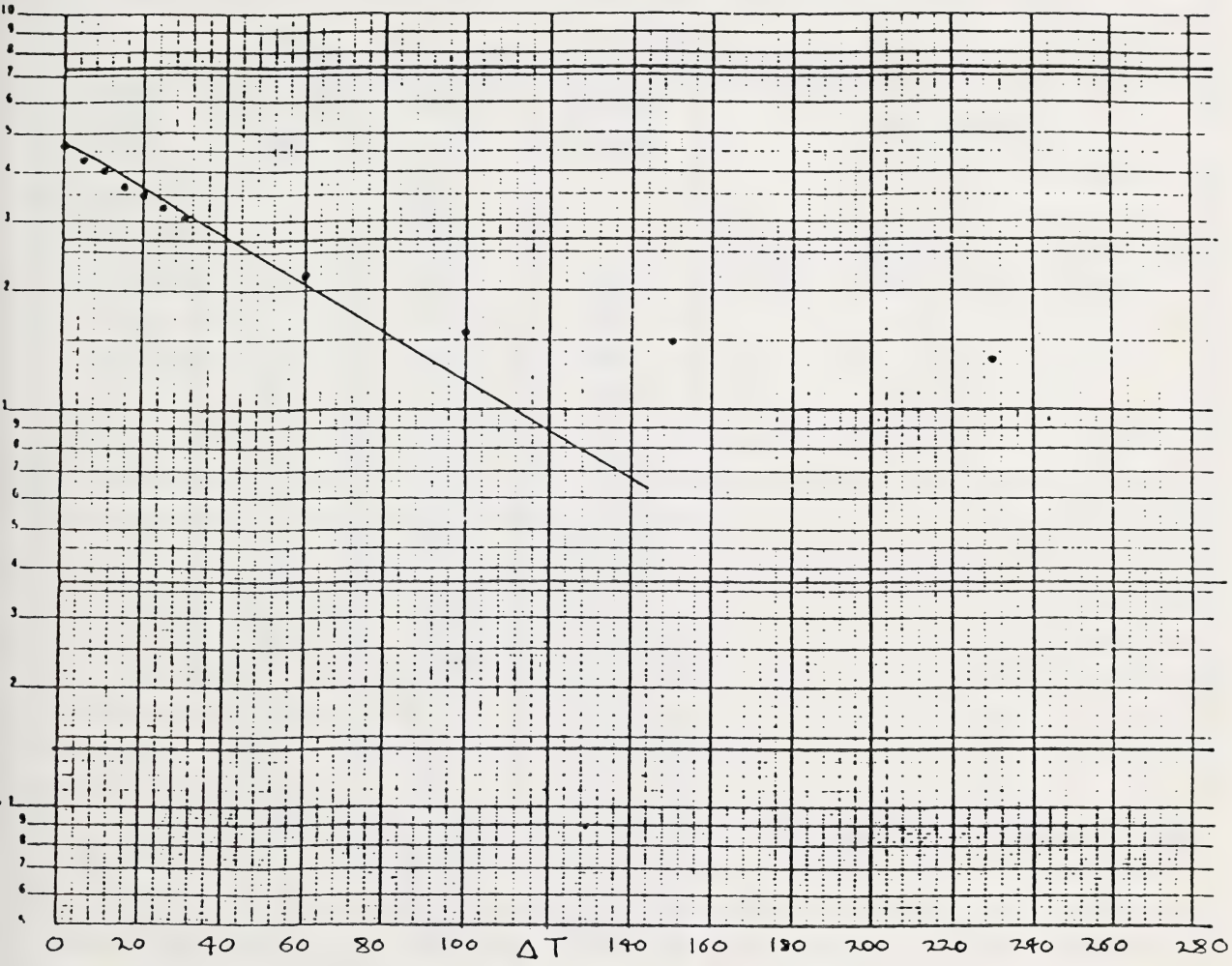
Pike Coulee (H-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 11:50		Dry		
25 14:11		Dry		Datum = 4.24m
14:15	0 min	2.98m	1.26m	Falling Head (Slug) Test
	1	3.23	1.01	
	2	3.35	0.89	
	3	3.44	0.80	
	4	3.50	0.74	
	5	3.55	0.69	
	10	3.67	0.57	
	15	3.73	0.51	
	20	3.75	0.49	
	25	3.76	0.48	
	30	3.77	0.47	
	145	3.89	0.35	
26 9:35	1160	4.20	0.04	
17:00	1605	4.20	0.04	

A-6 Permeability Test Sheet for Test No I P-1 (Slug Test) Sheet 1 of 2

est Interval 7.01 to 8.53 (metres)

23 to 28 (feet)



CULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 4200} \ln\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$

$K = 1.6 \times 10^{-5}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 4200 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

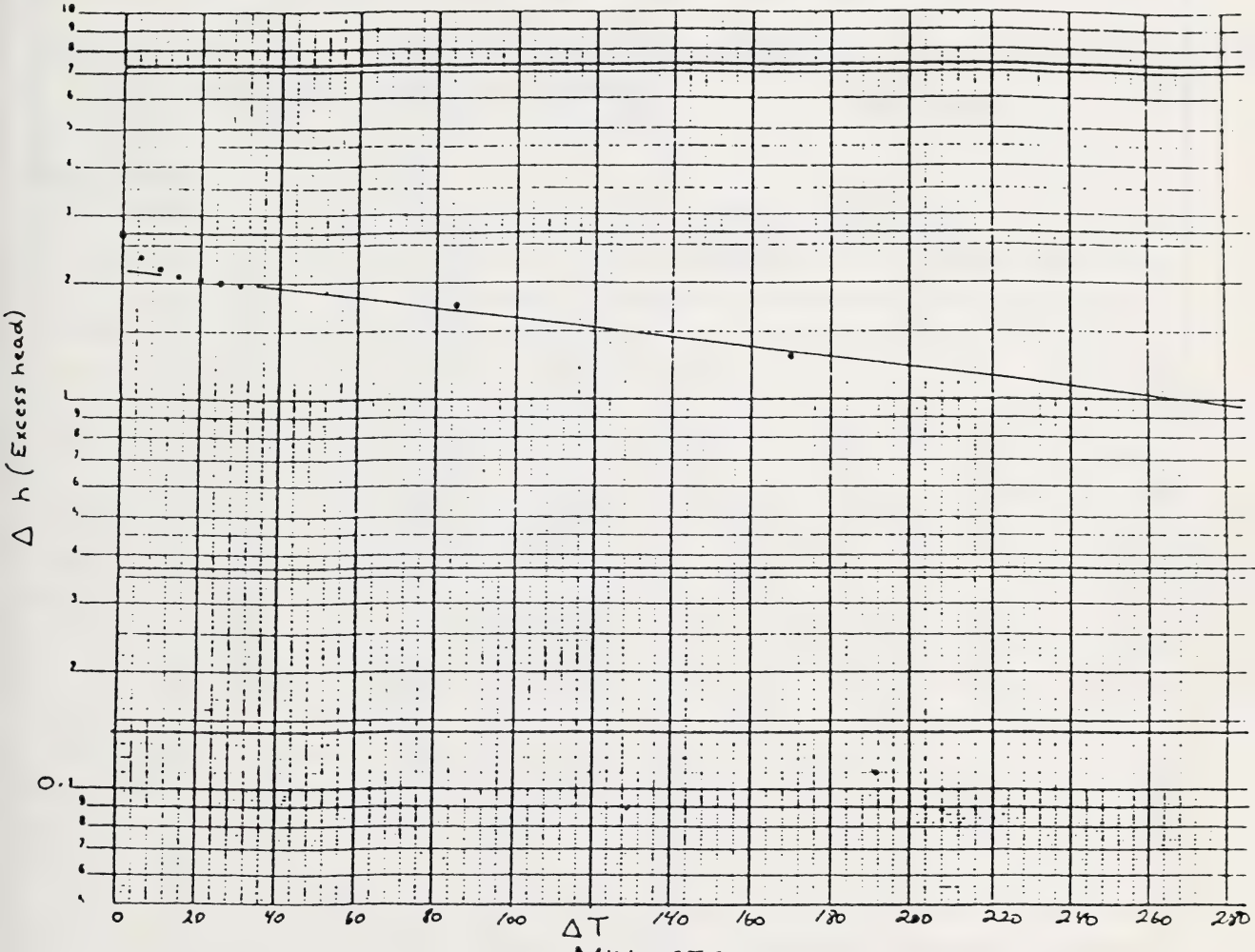
Pine Coulee (I-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 11:57		Dry		
25 11:54		Dry		Datum = 8.90m
12:20	0 min	4.22m	4.68m	Falling Head (Slug) Test
	1	4.29	4.61	
	2	4.35	4.55	
	3	4.42	4.48	
	4	4.50	4.40	
	5	4.58	4.32	
	10	4.91	3.99	
	15	5.21	3.69	
	20	5.43	3.47	
	25	5.66	3.24	
	30	5.86	3.04	
	60	6.73	2.17	
	100	7.33	1.57	
	150	7.41	1.49	
	230	7.56	1.34	
26 9:25	1265	8.26	0.64	
16:57	1717	8.35	0.55	
27 12:40	2900	8.61	0.29	

PA-6 Permeability Test Sheet for Test No I P-2 (Slug Test) Sheet 1 of 2

Test Interval 2.90 to 4.42 (metres)

9.5 to 14.5 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \text{Ln}\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 20{,}520} \text{Ln}\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$

$K = 3.3 \times 10^{-6}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 20,520 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

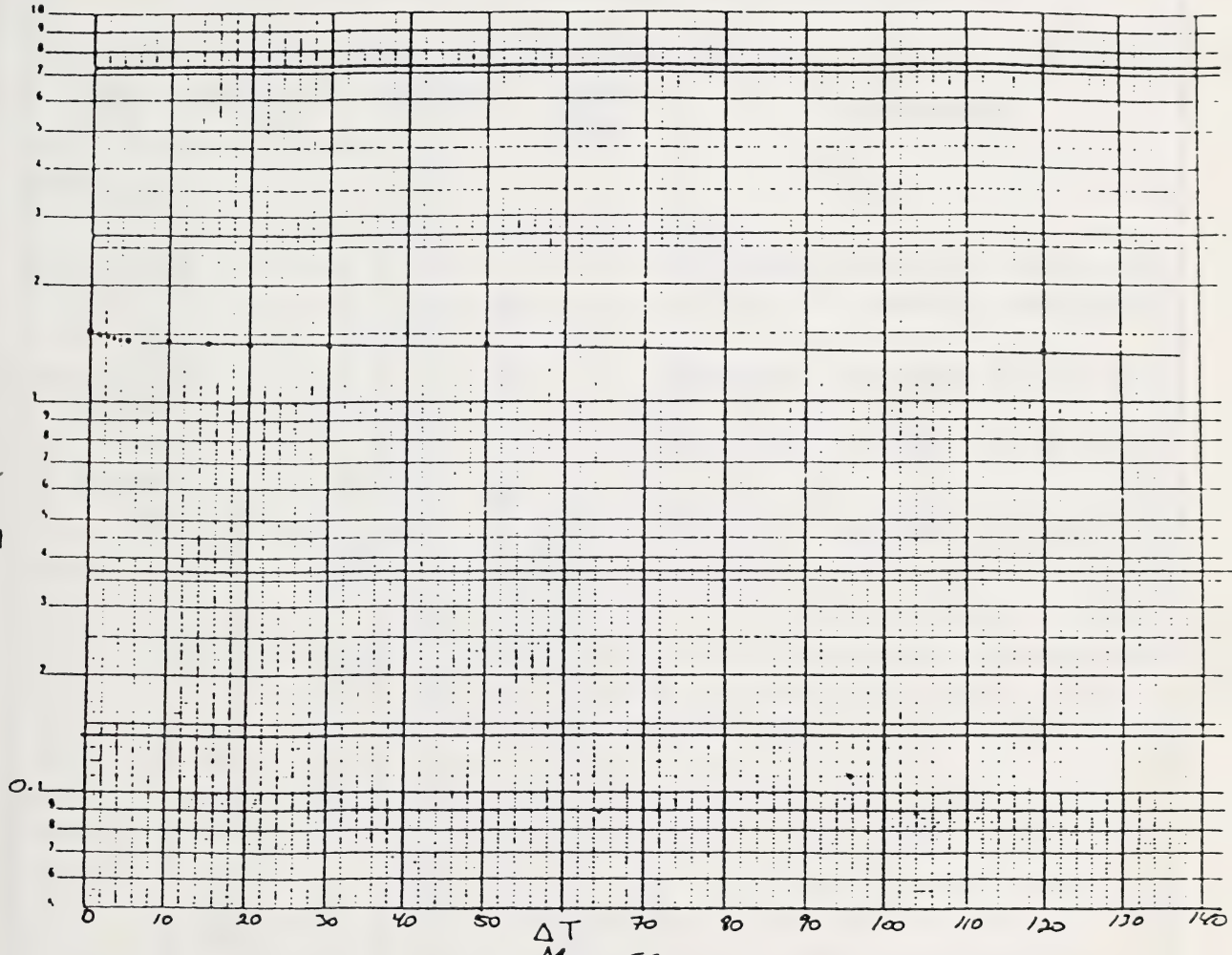
Pine Coulee (I-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 12:00		Dry		
25 11:54		Dry		Datum = 4.92 m
13:30	0 min	2.25 m	2.67 m	Falling Head (Slug) Test
	1	2.34	2.58	
	2	2.39	2.53	
	3	2.45	2.47	
	4	2.51	2.41	
	5	2.56	2.36	
	10	2.74	2.18	
	15	2.83	2.09	
	20	2.87	2.05	
	25	2.92	2.00	
	30	2.95	1.97	
	85	3.22	1.70	
	170	3.57	1.35	
26 9:30	1200	4.92	0.00	
16:58	1648	4.92	0.00	

PA-6 Permeability Test Sheet for Test No JP-1 (Bail Test) Sheet 1 of 2

Test Interval 5.49 to 7.01 (metres)

18 to 23 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$$K = \frac{5.25^2}{8 \times 152 \times 93{,}369} \ln\left(\frac{2\sqrt{1}}{20.3} \times 152\right)$$

$K = 6.6 \times 10^{-7}$ cm/sec

where: D = Hole diameter 20.3cm (8 in)

d = Tube diameter 5.25cm (2.067in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 93,369 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
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VANCOUVER CALGARY

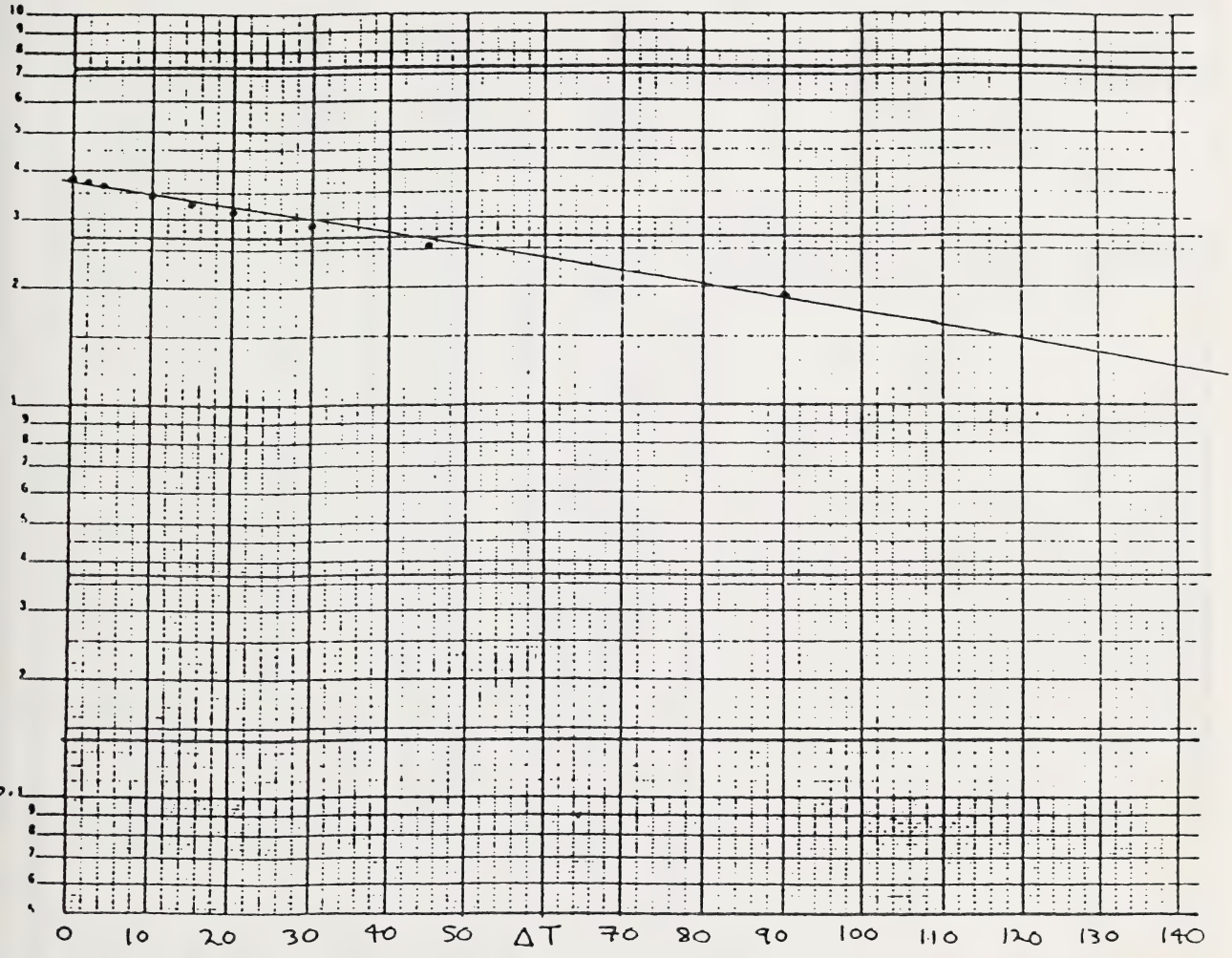
Pine Coulee (J-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 11:17		4.66m		
24 16:10		4.62		
16:17		5.57		Developed piezometer ⇒ clean water
25 15:29		4.75		Datum (for hydraulic cond. test)
26 16:08		4.69		
16:31		5.57		Developed piezometer with N_2 purge
27 17:20		4.68		
17:32		6.35		Developed piezometer by bailing.
28 10:00		5.24		
10:10	0 min	6.25	1.50m	Rising Head (Bail) Test.
	1	6.21	1.46	
	2	6.20	1.45	
	3	6.20	1.45	
	4	6.20	1.45	
	5	6.19	1.44	
	10	6.18	1.43	
	15	6.18	1.43	
	20	6.17	1.42	
	30	6.16	1.41	
	50	6.15	1.40	
	120	6.10	1.35	
	185	6.05	1.30	
	295	5.98	1.23	
	400	5.91	1.16	
29 8:50	1360	5.10	0.35	
16:40	1830	4.91	0.16	
30 9:30	2840	4.75	0.00	

A-6 Permeability Test Sheet for Test No J P-2 (Slug Test) Sheet 1 of 2

Test Interval 2.74 to 4.27 (metres)

9 to 14 (feet)



CULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 7{,}560} \ln\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$

$K = 9.0 \times 10^{-6}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 7,560 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
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VANCOUVER CALGARY

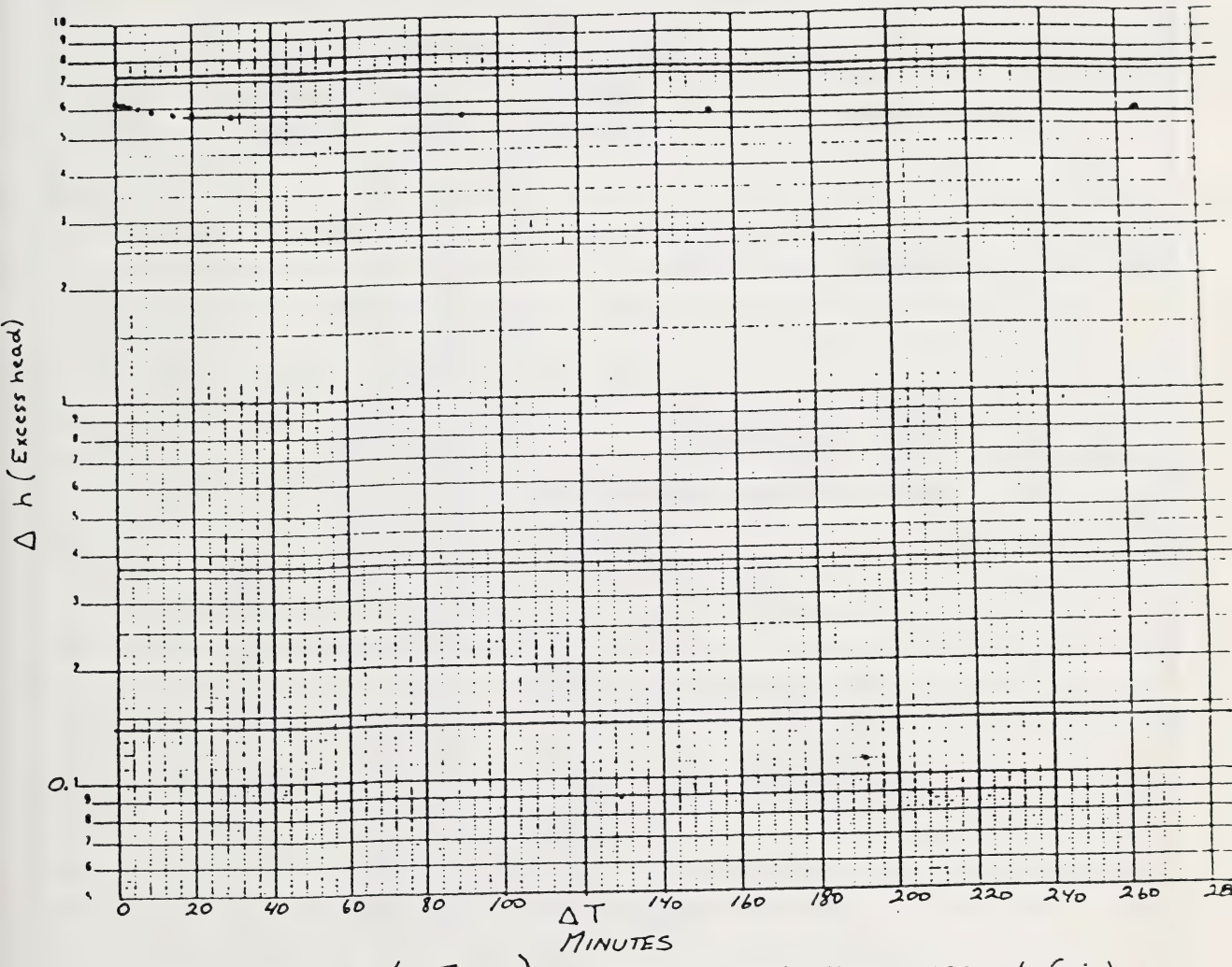
Pine Coulee (J-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 11:20		Dry		
26 16:11		Dry		Datum = 4.48m
16:20	0 min	0.61m	3.87m	Falling Head (Slug) Test
	1	0.67	3.81	
	2	0.71	3.77	
	3	0.76	3.72	
	4	0.80	3.68	
	5	0.85	3.63	
	10	1.02	3.46	
	15	1.18	3.30	
	20	1.33	3.15	
	30	1.59	2.89	
	45	1.93	2.55	
	90	2.58	1.90	
27 8:25	965	4.01	0.47	
12:35	1215	4.10	0.38	
17:20	1500	4.16	0.32	
28 10:00	2500	4.32	0.16	

PA-6 Permeability Test Sheet for Test No J P-3 (Bail Test) Sheet 1 of 2

Test Interval 18.29 to 21.34 (metres)

60 to 70 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2H}{D} \times L\right)$

$$K = \frac{5.25^2}{8 \times 305 \times 301{,}629} \ln\left(\frac{2\sqrt{T}}{15.2} \times 305\right)$$

$K = 1.4 \times 10^{-7}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 305 cm (120 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 301,629 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
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VANCOUVER CALGARY

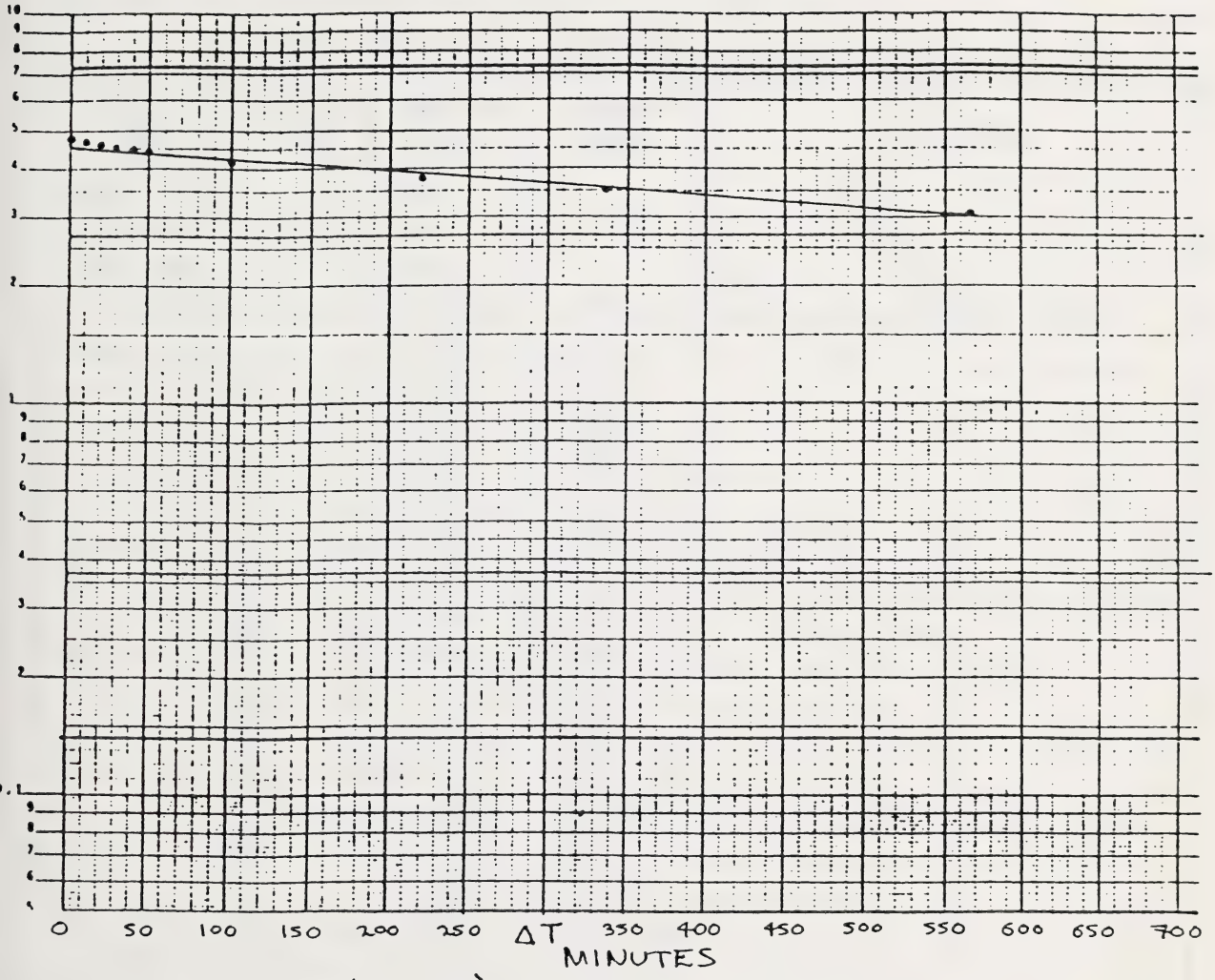
Pine Coulee (J-P3)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 11:21		13.77 m		
24 16:15		11.66		
16:20		15.89		Developed piezometer ⇒ clean water
25 15:30		14.05		
26 16:10		12.33		
27 17:20		10.82		
17:45		15.77		Developed piezometer by bailing.
28 10:00		14.38		Datum (for hydraulic cond. test)
10:40	0 min	20.44	6.06m	Rising Head (Bail) Test.
	1	20.41	6.03	
	2	20.37	5.99	
	3	20.35	5.97	
	4	20.34	5.96	
	5	20.33	5.95	
	10	20.31	5.93	
	15	20.29	5.91	
	20	20.27	5.89	
	30	20.25	5.87	
	90	20.20	5.82	
	155	20.15	5.77	
	265	20.09	5.71	
	370	20.01	5.63	
29 8:50	1330	19.38	5.00	
16:40	1800	19.06	4.68	
30 9:30	2810	18.08	3.70	

A-6 Permeability Test Sheet for Test No K P-1 (Slug Test) Sheet 1 of 2

est Interval 3.05 to 4.57 (metres)

10 to 15 (feet)



LCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 74{,}250} \ln\left(\frac{2\sqrt{1}}{20.3} \times 152\right)$

$K = 8.3 \times 10^{-7}$ cm/sec

where: D = Hole diameter 20.3 cm (8 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 74,250 seconds

GROUNDWATER SAMPLING FIELD RECORD

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VANCOUVER CALGARY

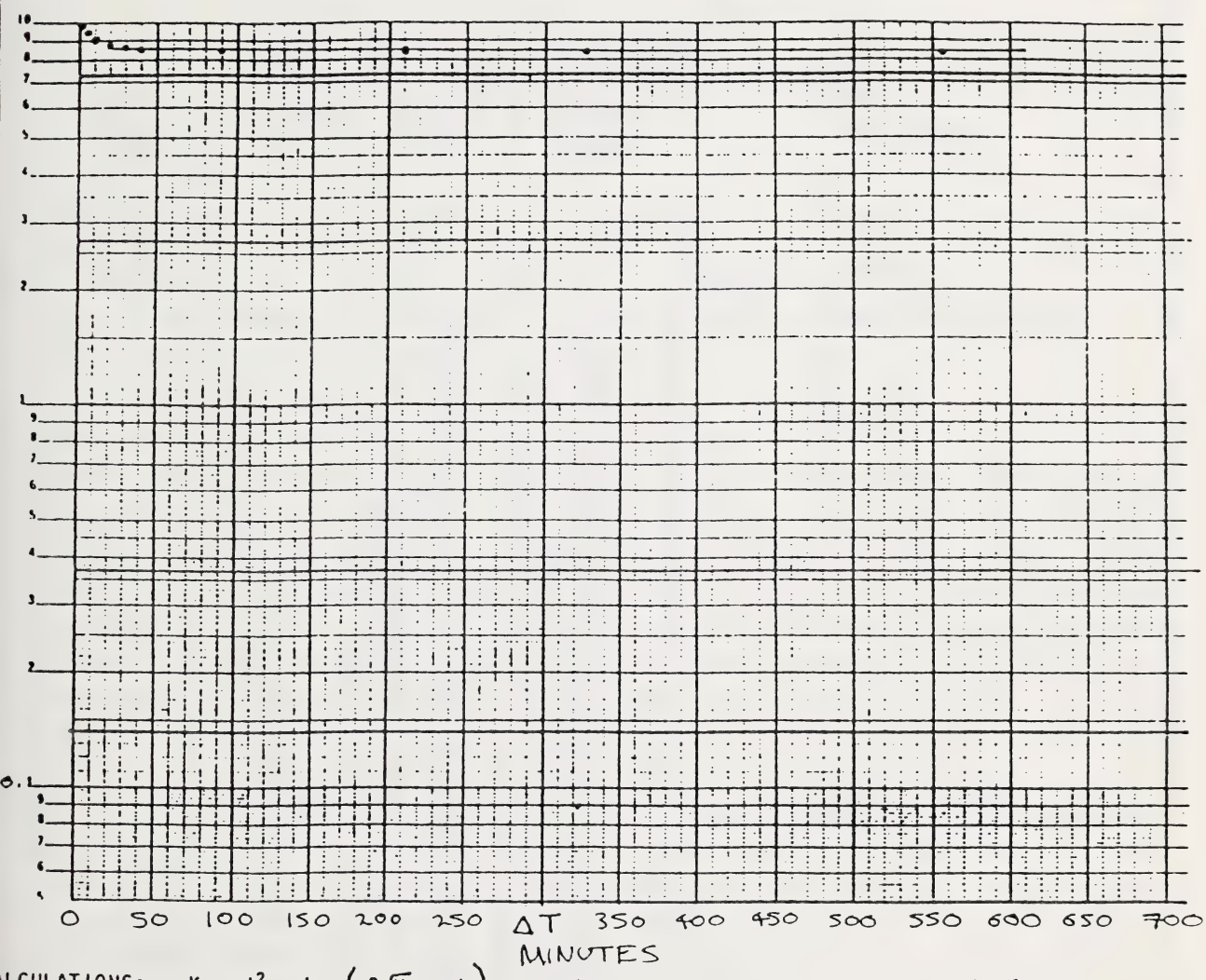
Pine Coulee (K-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 9:42		Dry		
25 15:50		Dry		
27 9:00		Dry		Datum = 4.99 m
9:10	0 min	0.20 m	4.79 m	Falling Head (Slug) Test
	1	0.23	4.76	
	2	0.25	4.74	
	3	0.26	4.73	
	4	0.27	4.72	
	5	0.28	4.71	
	10	0.32	4.67	
	15	0.36	4.63	
	20	0.40	4.59	
	30	0.45	4.54	
	40	0.50	4.49	
	50	0.56	4.43	
	100	0.78	4.21	
	220	1.20	3.79	
	335	1.49	3.50	
	565	1.96	3.03	
28 9:15	1445	3.03	1.96	
16:15	1865	3.33	1.66	
29 9:00	2870	3.60	1.39	
30 9:45	4355	3.60	1.39	

PA-6 Permeability Test Sheet for Test No K P-2 (Slug Test) Sheet 1 of 2

Test Interval 13.11 to 14.63 (metres)

43 to 48 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 201{,}658} \ln\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$

$K = 3.4 \times 10^{-7}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 201,658 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

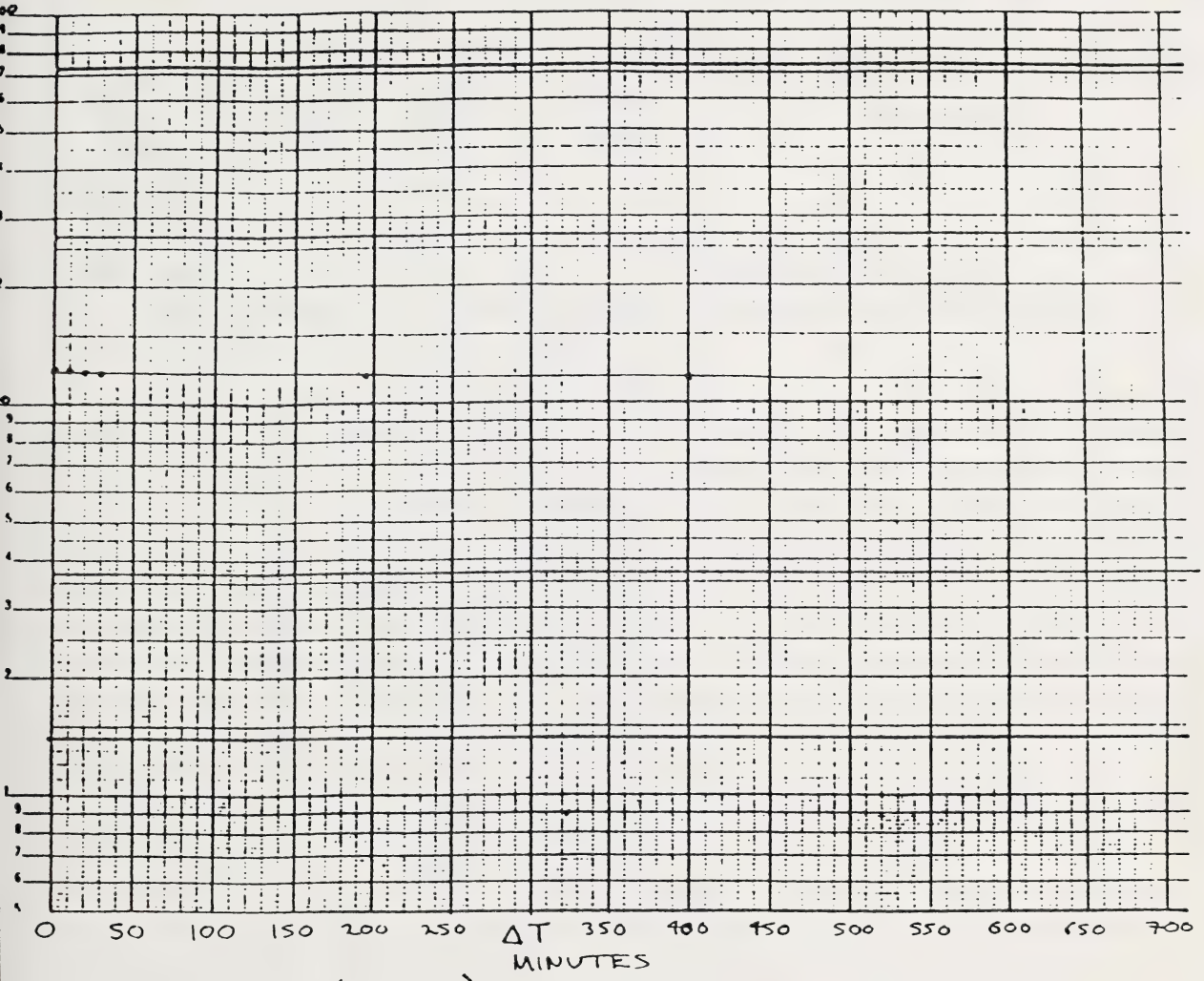
Pine Coulee (K-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 9:44		Dry		
25 15:50		Dry		
27 9:00		Dry		Datum = 14.95 m
9:20	0 min	5.03 m	9.92 m	Falling Head (Slug) Test
	1	5.13	9.82	
	2	5.22	9.73	
	3	5.32	9.63	
	4	5.43	9.52	
	5	5.52	9.43	
	10	5.92	9.03	
	15	6.13	8.82	
	20	6.20	8.75	
	30	6.26	8.69	
	40	6.30	8.65	
	90	6.40	8.55	
	210	6.47	8.48	
	325	6.50	8.45	
	555	6.54	8.41	
28 9:15	1435	6.63	8.32	
16:15	1855	6.66	8.29	
29 9:00	2860	6.71	8.24	
30 9:45	4345	6.78	8.17	

-6 Permeability Test Sheet for Test No L P-1 (Slug Test) Sheet 1 of 2

st Interval 13.41 to 14.94 (metres)

44 to 49 (feet)



CULATIONS: $K = \frac{d^2}{8LTi} \text{Ln}\left(\frac{2H}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 1{,}030{,}239} \text{Ln}\left(\frac{2 \times 1}{15.2} \times 152\right)$

$K = 6.6 \times 10^{-8}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.07 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 1,030,239 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

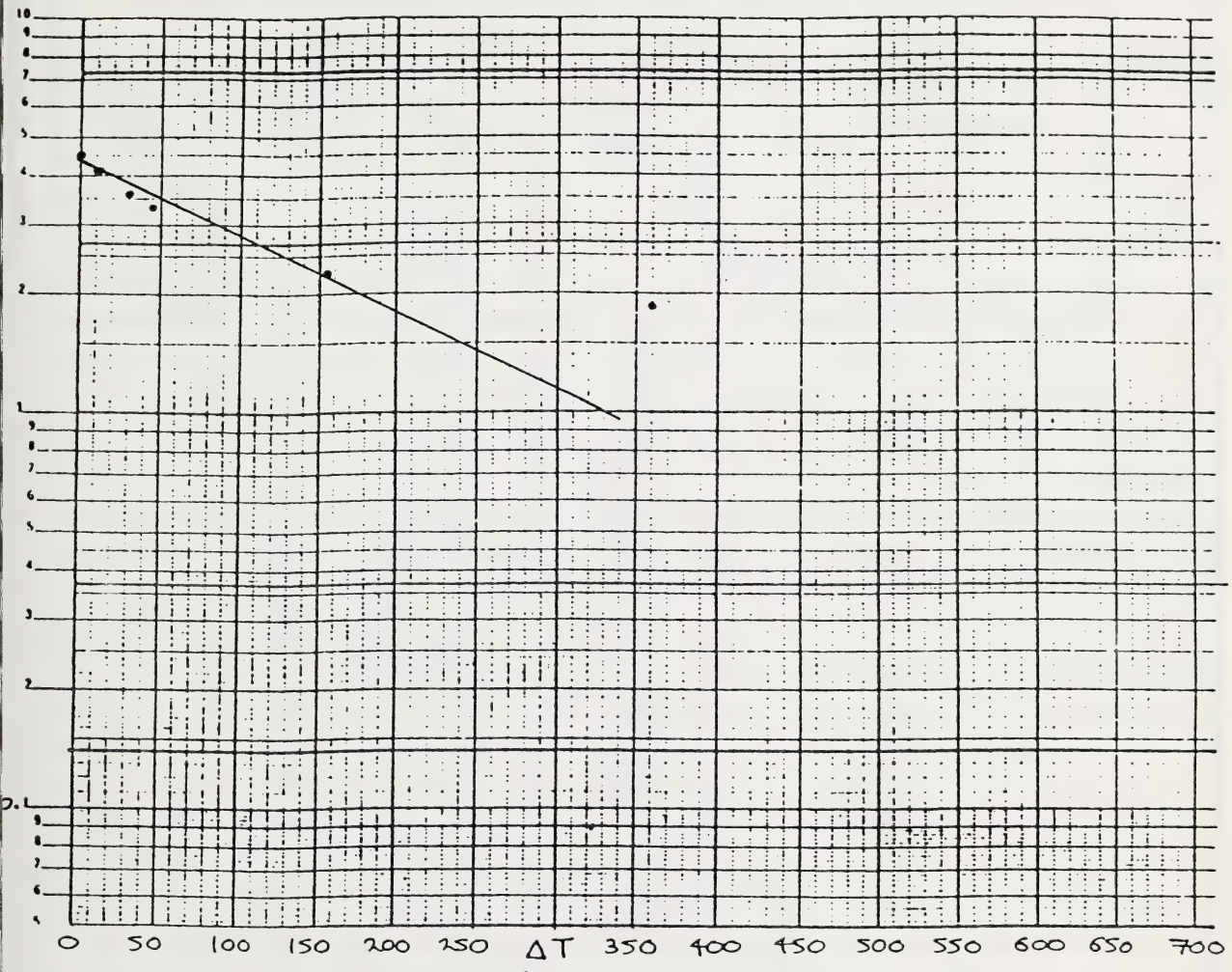
Pine Coulee (L-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 9:59		Dry		
25 16:05		Dry		
27 13:10		Dry		Datum = 15.21 m
13:45	0 min	3.05m	12.16 m	Falling Head (Slug) Test
	1	3.06	12.15	
	2	3.07	12.14	
	3	3.08	12.13	
	4	3.09	12.12	
	5	3.10	12.11	
	10	3.11	12.10	
	15	3.13	12.08	
	20	3.15	12.06	
	30	3.18	12.03	
	195	3.27	11.94	
	400	3.33	11.88	
28 9:25	1180	3.37	11.84	
16:35	1610	3.43	11.78	
29 9:25	2620	3.51	11.70	
30 10:15	4110	3.54	11.67	

PA-6 Permeability Test Sheet for Test No L P-2 (Slug Test) Sheet 1 of 2

Test Interval 3.05 to 4.57 (metres)

10 to 15 (feet)



CULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{M}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 13{,}020} \ln\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$

$K = 5.2 \times 10^{-6}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

M = K_H/K_V = ANISOTROPY

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 13,020 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

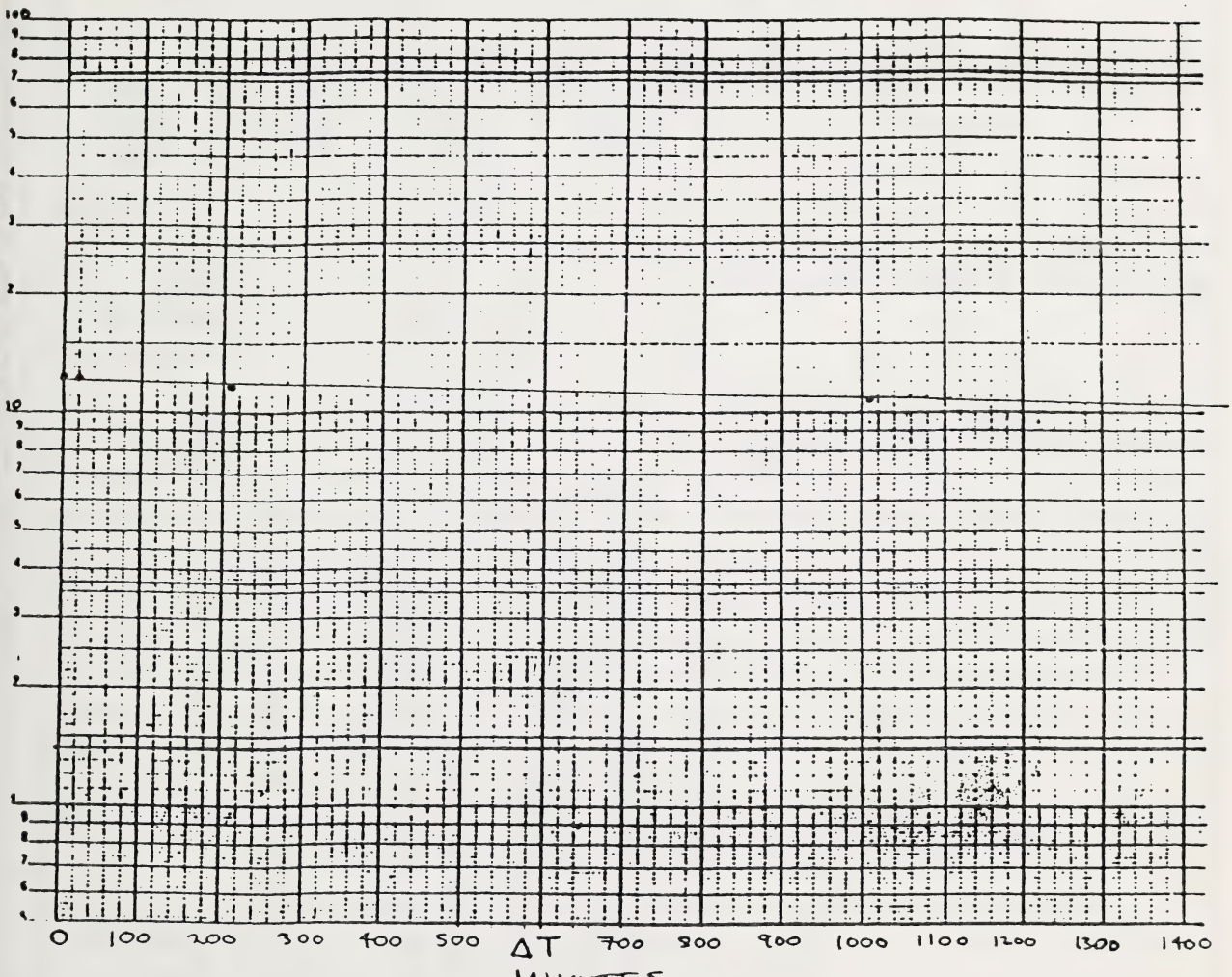
Pine Coulee (L-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 10:01		Dry		
25 16:01		Dry		
27 13:10		Dry		Datum = 4.95m
13:25	0 min	0.45m	4.50 m	Falling Head (Slug) Test.
	1	0.48	4.47	
	2	0.53	4.42	
	3	0.58	4.37	
	4	0.62	4.33	
	5	0.65	4.30	
	10	0.84	4.11	
	15	0.99	3.96	
	20	1.13	3.82	
	30	1.36	3.59	
	45	1.63	3.32	
	155	2.68	2.27	
	360	3.09	1.86	
28 9:25	1200	3.41	1.54	
11:35	1330	3.78	1.17	
29 9:25	2640	4.03	0.92	
30 10:15	4130	4.25	0.70	

Permeability Test Sheet for Test No M P-1 (Slug Test) Sheet 1 of 2

Test Interval 12.04 to 12.65 (metres)

39.5 to 41.5 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 61 \times 1{,}028{,}396} \ln\left(\frac{2\sqrt{1}}{15.2} \times 61\right)$

$K = 1.1 \times 10^{-7}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 61 cm (24 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 1,028,396 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

Pine Coulee (M-P1)

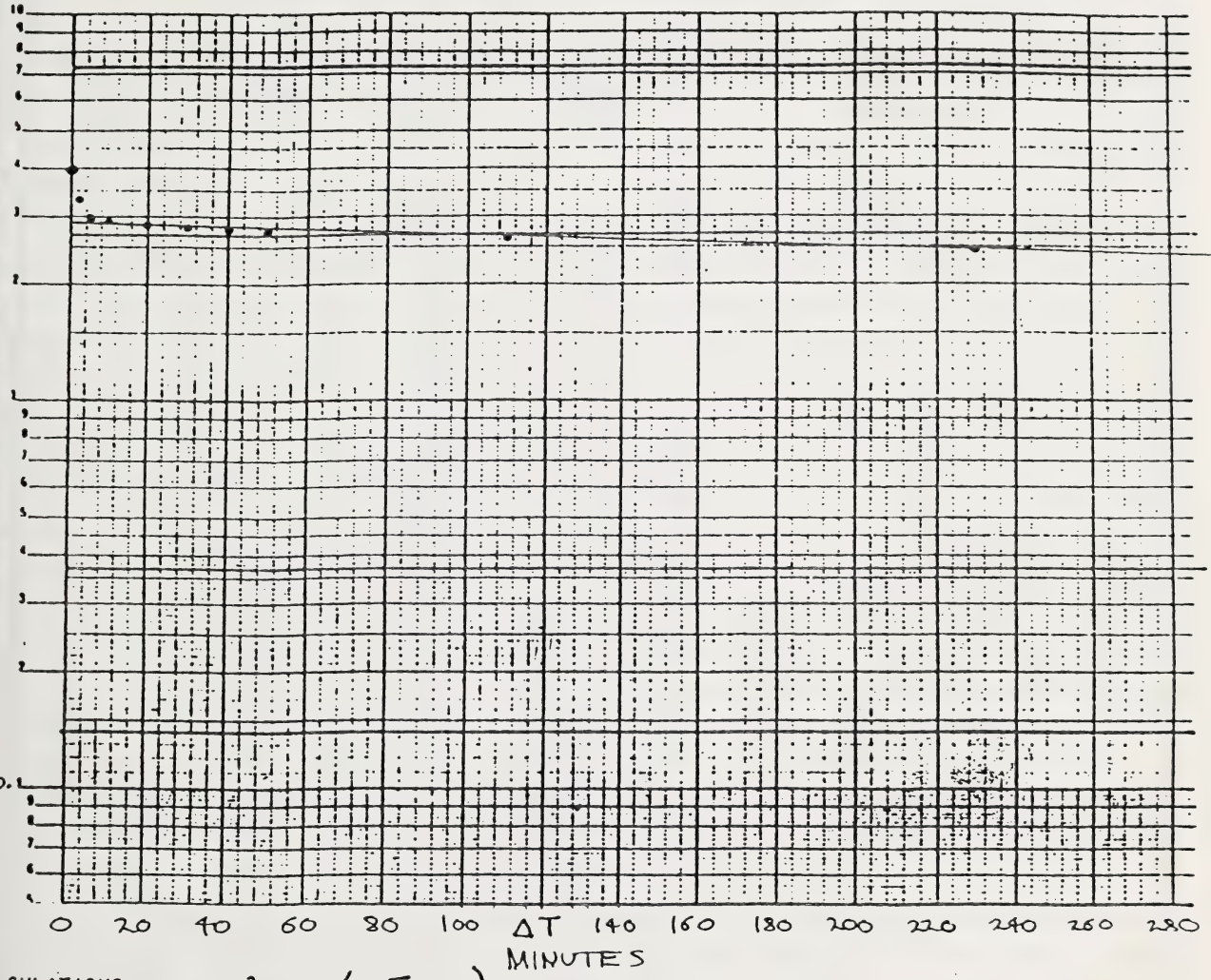
DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 10:20		12.29m		
24 15:10		12.28		
15:15		—		Attempted to develop with N_2 purge
26 13:23		12.07		
27 8:45		12.01		
9:50		12.92		Developed by bailing
14:55		12.99		Developed by bailing
15:00		12.98		Datum = 13.06 m
15:15	0 min	0.74	12.32m	Falling Head (Slug) Test
	1	0.74	12.32	
	2	0.74	12.32	
	3	0.74	12.32	
	4	0.74	12.32	
	5	0.74	12.32	
	10	0.75	12.31	
	15	0.77	12.29	
	20	0.78	12.28	
	30	0.80	12.26	
	210	1.30	11.76	
28 9:30	1095	2.09	10.97	
16:25	1510	2.32	10.74	
29 9:10	2515	2.78	10.28	
30 10:05	4010	3.31	9.75	

PA-6 Permeability Test Sheet for Test No M P-2 Sheet 1 of 2

(Slug Test)

Test Interval 3.05 to 4.57 (metres)

10 to 15 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 84{,}672} \ln\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$

$K = 8.0 \times 10^{-7}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 84,672 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

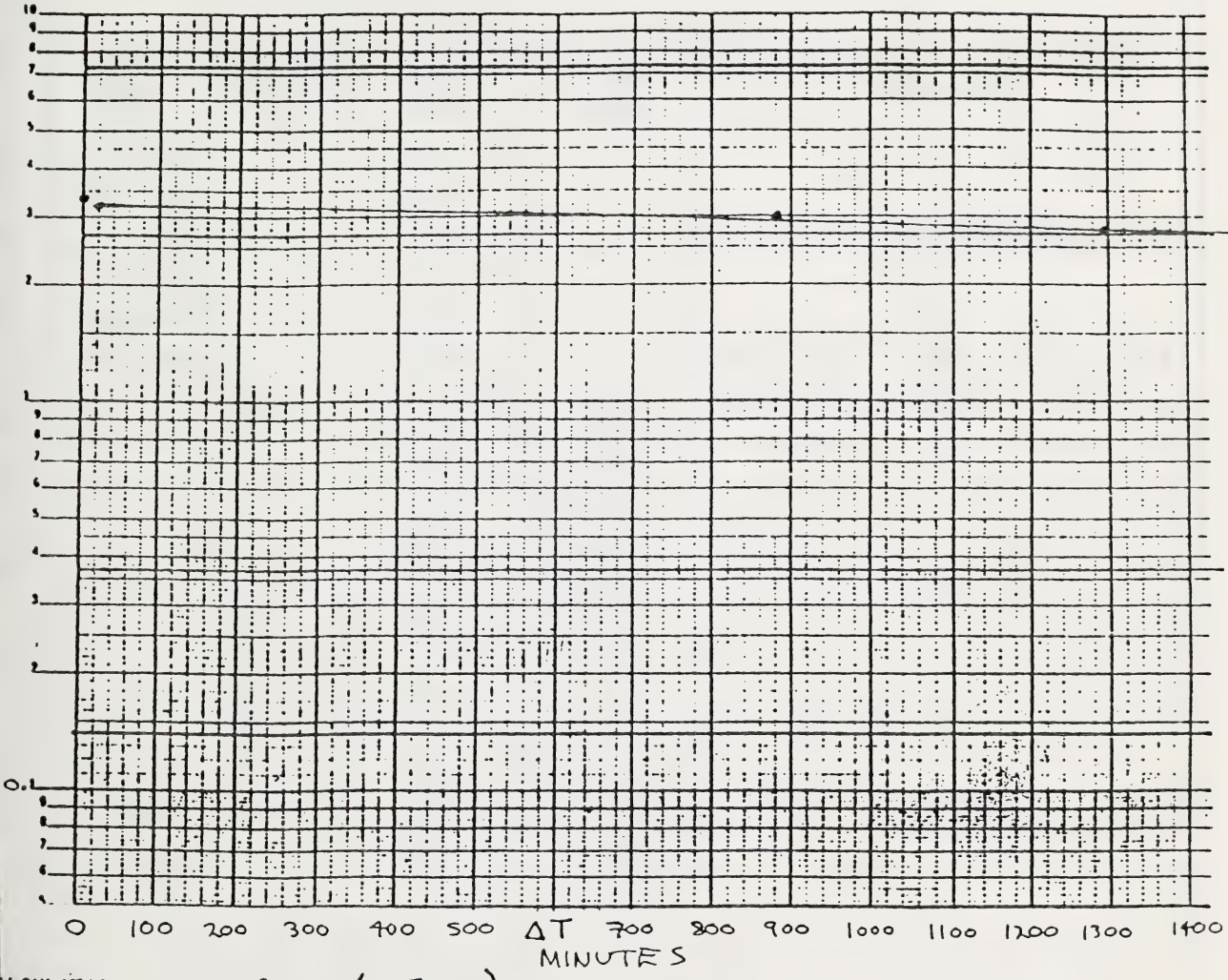
Pine Coulee (M-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 10:25		Dry		
24 15:11		Dry		Datum = 4.94m
26 13:40	0min	0.95m	3.99m	Falling Head (Slug) Test
	1	1.37	3.57	
	2	1.65	3.29	
	3	1.83	3.11	
	4	1.92	3.02	
	5	1.98	2.96	
	10	2.03	2.91	
	15	2.06	2.88	
	20	2.08	2.86	
	30	2.13	2.81	
	40	2.17	2.77	
	50	2.20	2.74	
	110	2.33	2.61	
	230	2.49	2.45	
27 8:45	1145	3.09	1.85	
14:55	1515	3.22	1.72	
15:35	1555	3.24	1.70	
18:45	1745	3.30	1.64	
28 9:30	2630	3.54	1.40	
16:25	3045	3.62	1.32	
29 9:10	4050	3.69	1.25	
30 10:05	5545	3.69	1.25	

PA-6 Permeability Test Sheet for Test No N P-1 (Bail Test) Sheet 1 of 2

Test Interval 9.75 to 14.33 (metres)

32 to 47 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 457 cm (180 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 416,601 seconds

$$K = \frac{5.25^2}{8 \times 457 \times 416{,}601} \ln\left(\frac{2\sqrt{1}}{15.2} \times 457\right)$$

$$K = 7.4 \times 10^{-8} \text{ cm/sec}$$

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

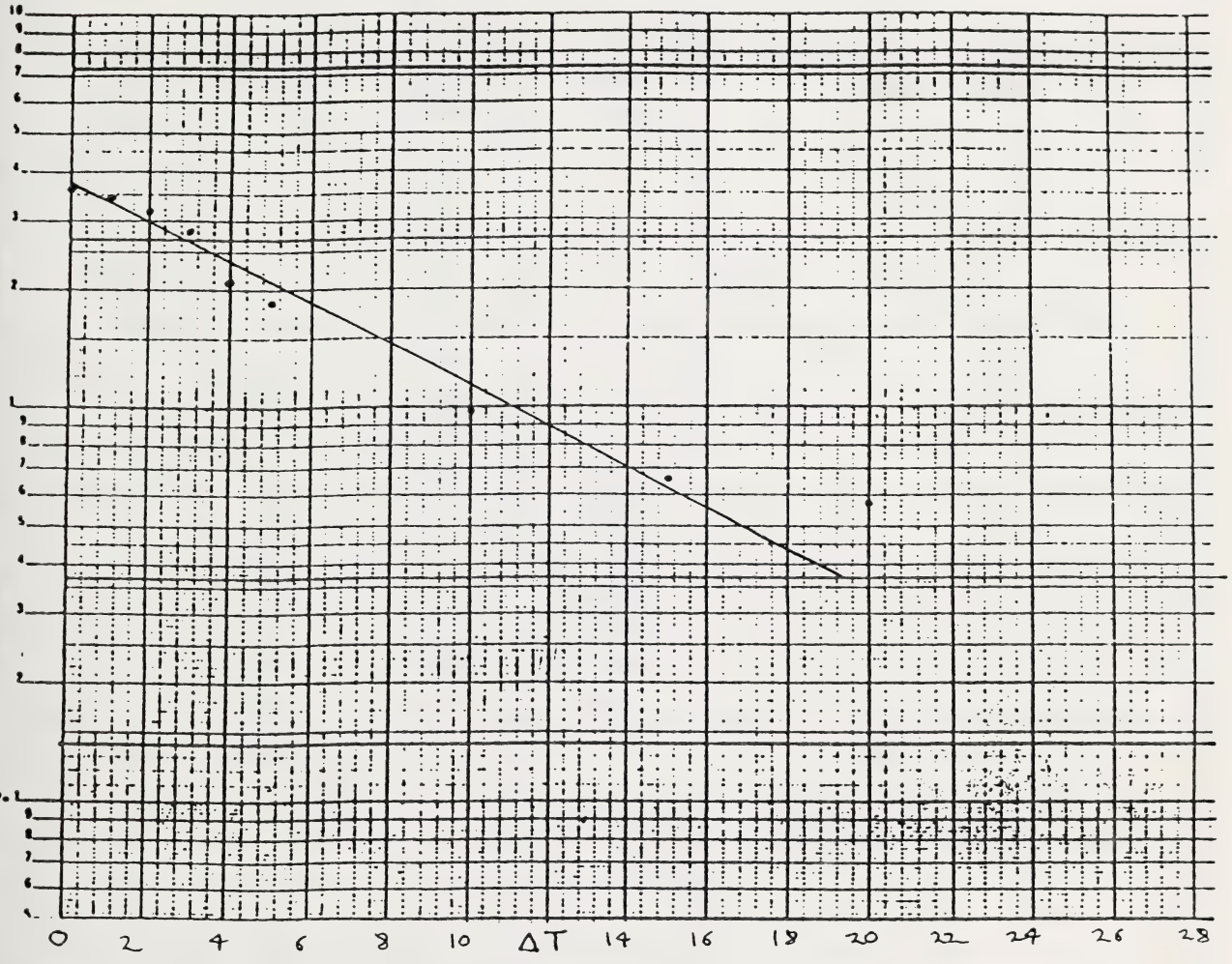
Pine Coulee (N-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 10:40		10.33m		
24 15:40		10.16		
15:45		11.35		Developed piezometer ⇒ clean water
25 15:42		11.08		
26 10:38		10.83		
27 17:00		10.52		Datum (For hydraulic cond. test)
18:30	0 min	13.87	3.35m	Rising Head (Bail) Test
	1	13.86	3.34	
	2	13.85	3.33	
	3	13.82	3.30	
	4	13.81	3.29	
	5	13.81	3.29	
	10	13.77	3.25	
	15	13.75	3.23	
	20	13.71	3.19	
	30	13.68	3.16	
28 9:10	880	13.50	2.98	
16:05	1295	13.30	2.78	
29 9:00	2310	12.79	2.27	
30 9:40	3790	12.06	1.54	

PA-6 Permeability Test Sheet for Test No NP-2 (Slug Test) Sheet 1 of 2

Test Interval 2.74 to 3.66 (metres)

9 to 12 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2H}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 91 \times 480} \ln\left(\frac{2H}{15.2} \times 91\right)$

$K = 2.0 \times 10^{-4}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 91 cm (36 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 480 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

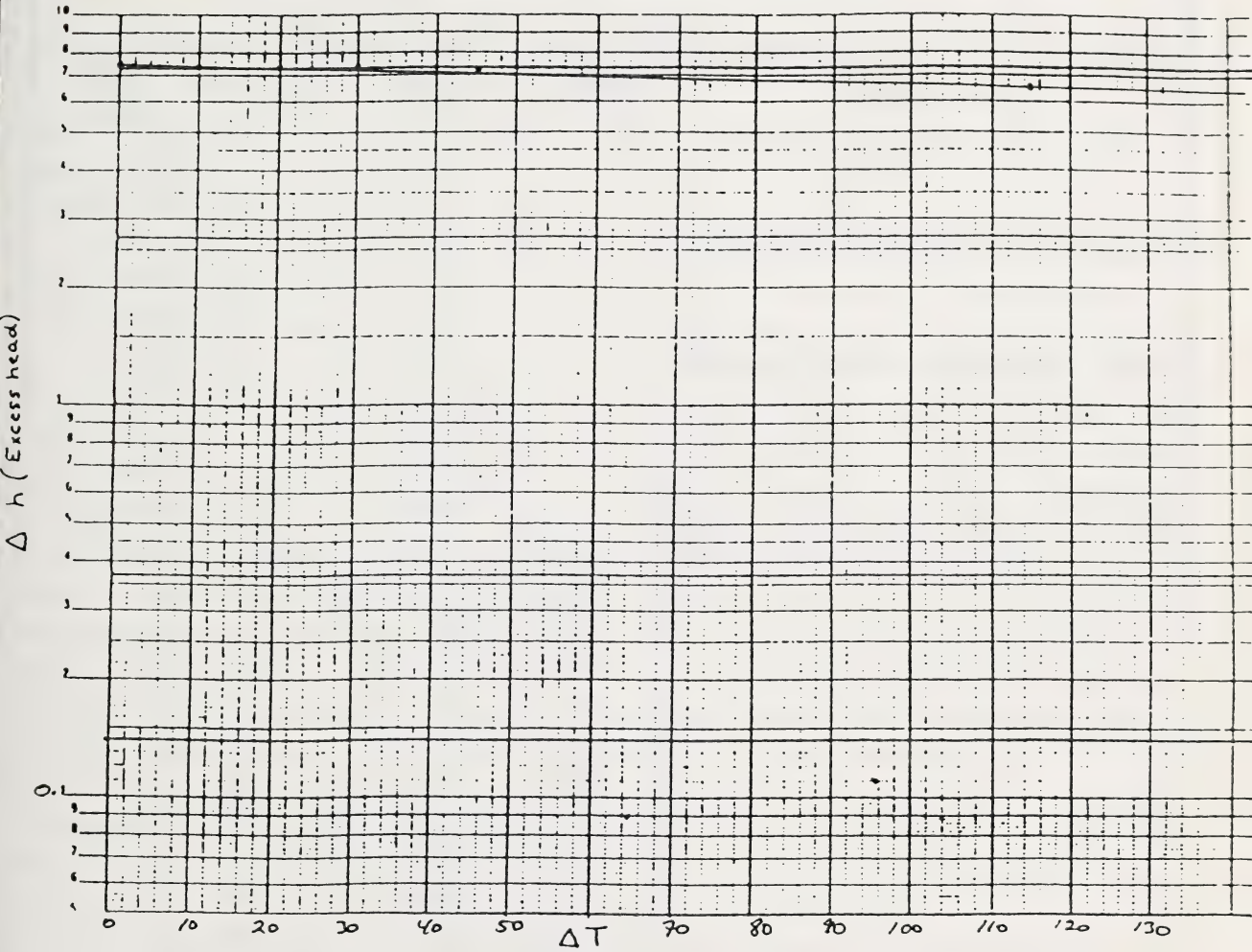
Pine Coulee (N-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 10:42		Dry		
24 15:45		Dry		
25 15:45		Dry		
26 10:36		Dry		Datum = 4.09 m
10:50	0 min	0.47m	3.63m	Falling Head (Slug) Test
	1	0.60	3.44	
	2	0.88	3.16	
	3	1.25	2.79	
	4	1.94	2.10	
	5	2.18	1.86	
	10	3.05	0.99	
	15	3.38	0.66	
	20	3.46	0.58	
	30	3.58	0.46	
	120	4.10	—	
17:15	365	4.10	—	

PA-6 Permeability Test Sheet for Test No O P-1 (Bail Test) Sheet 1 of 2

Test Interval 13.11 to 14.63 (metres)

43 to 48 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \text{Ln}\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 152 \times 61{,}992} \text{Ln}\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$

$K = 1.1 \times 10^{-6}$ cm/sec

where: D = Hole diameter 15.2cm (6 in)

d = Tube diameter 5.25cm (2.067in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 61,992 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

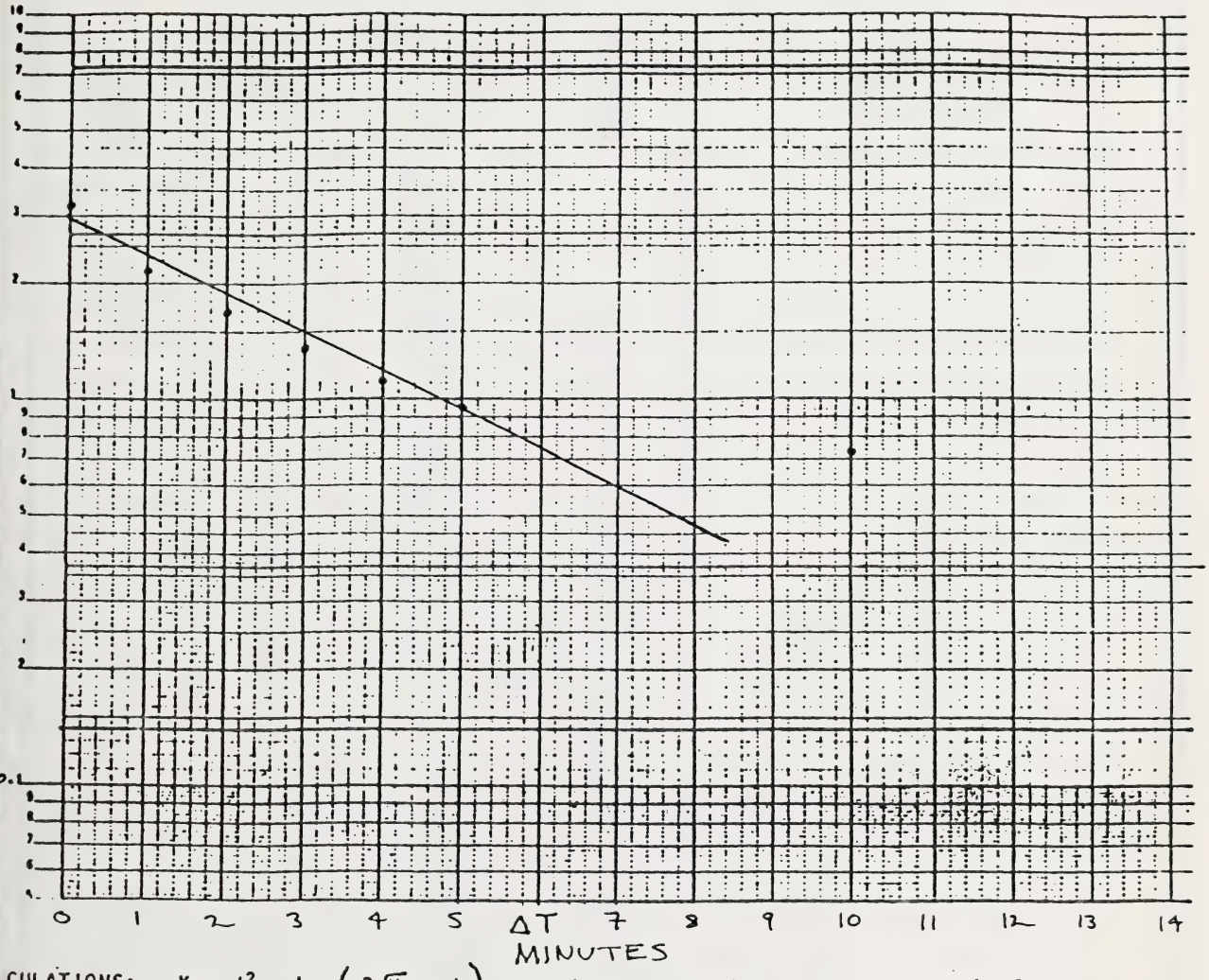
Pine Coulee (O-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 11:03		6.01 m		
24 15:50		6.00		
16:00		12.06		Developed piezometer ⇒ clean water
25 15:36		7.72		
26 9:43		6.93		
10:12		7.98		Developed piezometer ⇒ clean water.
17:42		7.31		
27 8:30		6.77		
12:40		6.66		
16:15		6.65		Datum (For hydraulic cond. test)
16:30	0 min	14.15	7.50 m	Rising Head (Bail) Test
	1	14.13	7.48	
	2	14.12	7.47	
	3	14.11	7.46	
	4	14.10	7.45	
	5	14.08	7.43	
	10	14.04	7.39	
	15	14.01	7.36	
	20	13.99	7.34	
	30	13.96	7.31	
	45	13.87	7.22	
	115	13.36	6.71	
28 9:05	995	10.53	3.88	
16:00	1410	9.86	3.21	
29 8:55	2425	8.47	1.82	
30 9:35	3905	7.31	0.66	

PA-6 Permeability Test Sheet for Test No O P-2 (Slug Test) Sheet 1 of 2

Test Interval 2.74 to 3.66 (metres)

9 to 12 (feet)



CALCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$K = \frac{5.25^2}{8 \times 91 \times 288} \ln\left(\frac{2\sqrt{1}}{15.2} \times 91\right)$

$K = 3.3 \times 10^{-4}$ cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 91 cm (36 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 288 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

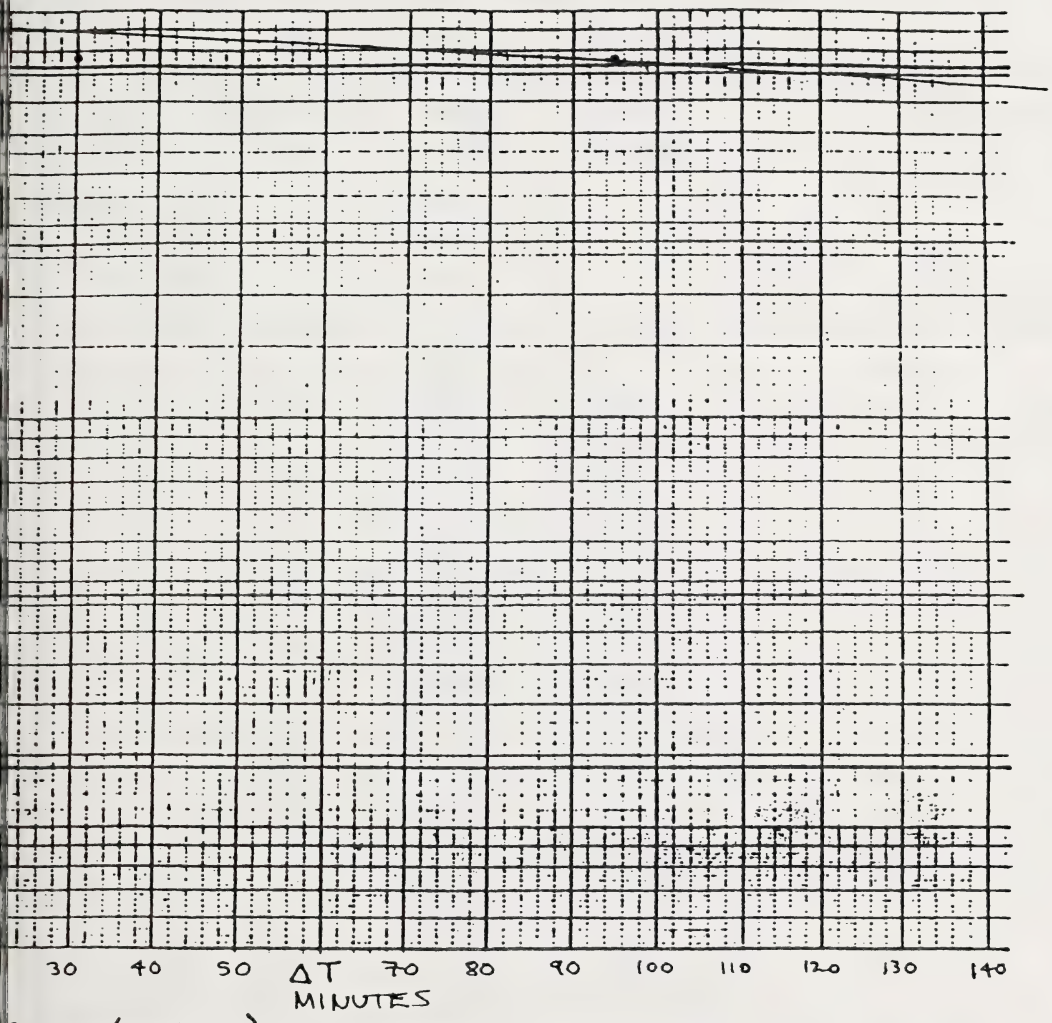
Pine Coulee (O-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 11:06		Dry		
24 16:10		Dry		
25 15:35		Dry		
26 9:43		Dry		Datum = 3.98 m
10:00	0 min	0.80 m	3.18 m	Falling Head (Slug) Test
	1	1.81	2.17	
	2	2.27	1.71	
	3	2.64	1.34	
	4	2.86	1.12	
	5	3.01	0.97	
	10	3.25	0.73	
	15	3.27	0.71	
	20	3.28	0.70	
	30	3.28	0.70	
	90	3.37	0.61	
	180	3.47	0.51	
	360	3.58	0.40	
	430	3.62	0.36	
	465	3.64	0.34	
27 8:30	1350	3.88	0.10	
12:40	1600	3.91	0.07	
16:15	1815	3.93	0.05	
18:25	1945	3.94	0.04	

Permeability Test Sheet for Test No P P-1 (Slug Test) Sheet 1 of 2

to 17.83 (metres)

to 58.5 (feet)



$\frac{2}{Ti}$ $Ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$\frac{}{46,842} Ln\left(\frac{2\sqrt{1}}{15.2} \times 305\right)$

10^{-7} cm/sec

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 305 cm (120 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 46,842 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

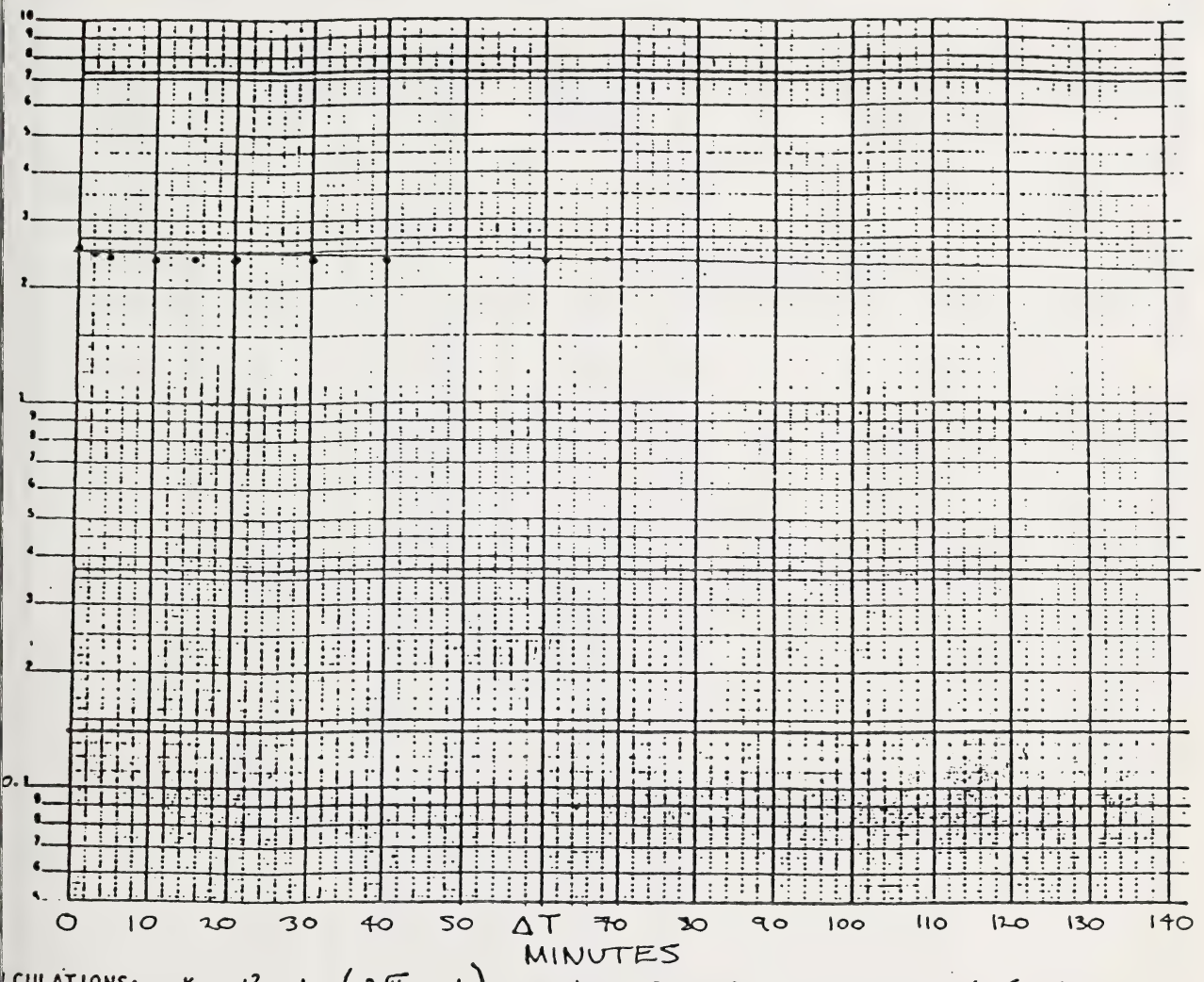
Pine Coulee (P-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 23 10:14		Dry		
25 16:08		Dry		
27 10:05		Dry		Datum = 18.24 m
10:15	0 min	8.53 m	9.71 m	Falling Head (Slug) Test
	1	8.57	9.67	
	2	8.62	9.62	
	3	8.72	9.52	
	4	8.83	9.41	
	5	8.97	9.27	
	10	10.16	8.08	
	15	10.38	7.86	
	20	10.40	7.84	
	30	10.41	7.83	
	95	10.41	7.83	
	170	10.43	7.81	
	350	10.44	7.80	
	545	10.45	7.79	
28 9:25	1390	10.45	7.79	
16:30	1815	10.45	7.79	
29 9:20	2825	10.45	7.79	
30 10:10	4315	10.46	7.78	

PA-6 Permeability Test Sheet for Test No Q P-1 (Slug Test) Sheet 1 of 2

Test Interval 1.37 to 2.29 (metres)

4.5 to 7.5 (feet)



CULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.067 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 91 cm (36 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 980,574 seconds

$$K = \frac{5.25^2}{8 \times 91 \times 980{,}574} \ln\left(\frac{2\sqrt{1}}{15.2} \times 91\right)$$

$$K = 9.6 \times 10^{-8} \text{ cm/sec}$$

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

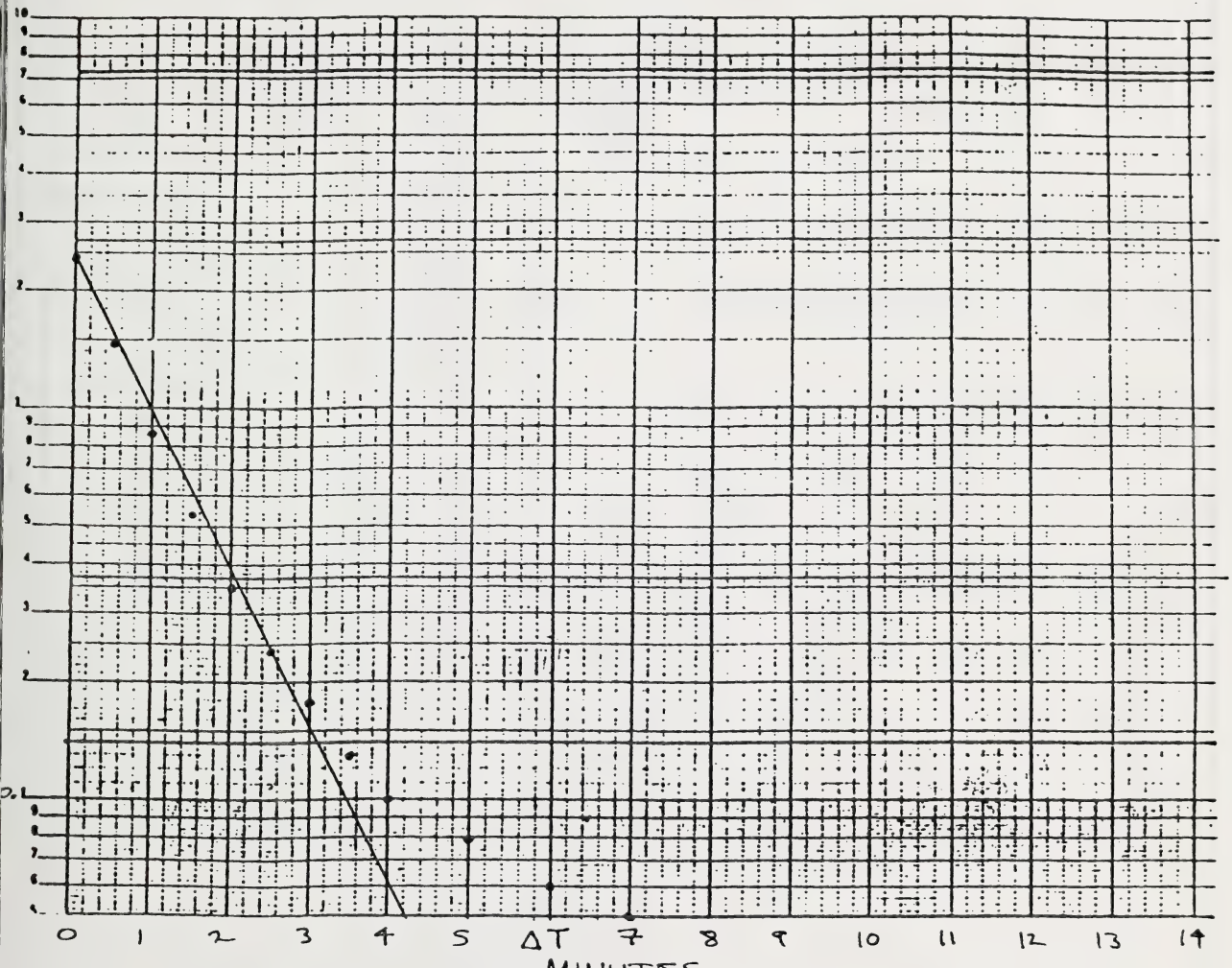
Pine Coulee (Q-P1)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 24 15:00		Dry		
25 15:56		Dry		
26 14:40		Dry		Datum = 2.71 m
14:45	0 min	0.20 m	2.51 m	Falling Head (Slug) Test
	1	0.25	2.46	
	2	0.27	2.44	
	3	0.28	2.43	
	4	0.30	2.41	
	5	0.30	2.41	
	10	0.32	2.39	
	15	0.32	2.39	
	20	0.33	2.38	
	30	0.33	2.38	
	40	0.35	2.36	
	60	0.35	2.36	
	155	0.38	2.33	
27 8:40	1085	0.53	2.18	
	1330	0.56	2.15	
	1415	0.57	2.14	
	1510	0.58	2.13	
	1675	0.60	2.11	
28 9:20	2555	0.69	2.02	
16:20	2975	0.72	1.99	
29 9:05	3980	0.81	1.90	
30 9:50	5465	0.92	1.79	

A-6 Permeability Test Sheet for Test No Q P-2 (Bail Test) Sheet 1 of 2

est Interval 6.71 to 8.23 (metres)

22 to 27 (feet)



LCULATIONS: $K = \frac{d^2}{8LTi} \ln\left(\frac{2\sqrt{H}}{D} \times L\right)$

$$K = \frac{5.25^2}{8 \times 152 \times 66} \ln\left(\frac{2\sqrt{1}}{15.2} \times 152\right)$$

$K = 1.0 \times 10^{-3}$ cm/sec.

where: D = Hole diameter 15.2 cm (6 in)

d = Tube diameter 5.25 cm (2.07 in)

H = K_H/K_V = ANISOTROPY = 1

K = Hydraulic Conductivity

L = Test Length 152 cm (60 in)

Ti = Time Interval for Excess Head (h) to Decay by 63%

= Time for Excess to Drop from One Bold Line to the Next Bold Line

= 66 seconds

GROUNDWATER SAMPLING FIELD RECORD

PITEAU & ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

Pine Coulee (Q-P2)

DATE AND TIME	ELAPSED TIME	WATER LEVEL	DRAW-DOWN	REMARKS
Aug 24 15:10		3.65m		
15:15		6.65		Developed piezometer ⇒ clean water
25 15:57		2.64		
26 15:50		4.04		Developed piezometer with N_2 purge
17:21		2.39		
27 8:40		2.38		
11:03		3.10		Developed piezometer by bailing
11:05		2.42		
12:55		2.38		Datum (for hydraulic cond. test)
13:00		4.12		
14:30	0 min	4.86	2.48	Rising Head (Bail) Test
	0.5	3.85	1.47	
	1	3.25	0.87	
	1.5	2.92	0.54	
	2	2.73	0.35	
	2.5	2.62	0.24	
	3	2.56	0.18	
	3.5	2.51	0.13	
	4	2.48	0.10	
	5	2.46	0.08	
	6	2.44	0.06	
	7	2.43	0.05	
	10	2.42	0.04	
	85	2.39	0.01	
	250	2.38	0.00	
28 9:20	1130	2.37	—	
16:20	1550	2.37	—	
30 9:50	2600	2.36	—	

LOCAL WATER SUPPLY WELLS

(Alberta Environment Records)

FIELD OBSERVATIONS:
Type of observation
Comments:

Date

Observed by:

WELL AND BOREHOLE DATA
Owner Provincial Park Address Willow Creek Date
Driller Type of Rig drilled
Completed Depth of Well 80'

Water-Bearing Intervals		Depth to Water
From	to	
From	to	
From	to	
From	to	

Well Construction		
(a) Slotted casing	From	to
(b) Open hole	From	to
(c) Screen	From	to
(d) Dug		
(e) Bored		

Depth to water in Finished Well

Water Temp. °F °C

AQUIFER TESTS

Type	Transmissivity	Q_{20}
Pump Test		
Bail Test		
Recovery Test		
Apparent-Yield Test		

Test rate igpm. for min.
Total Drawdown
Original available drawdown
Storage Coeff. at r_1
at r_2
at r_3

CHEMISTRY 28/5/81

	ppm	epm %
Calcium	40.	30.
Magnesium	26.	32.5
Sodium	56.300	36.52
Potassium	2.5	.96
Iron	.04	.02
Nitrate (NO_3)	6.24	1.39
Chloride	3.	1.16
Sulfate (SO_4)	42.	12.05
Fluoride	.42	.30
Carbonate (CO_3)	-	-
Bicarbonate (HCO_3)	377.	85.1
Silica (H_4SiO_4)	6.3	
Hardness (as($CaCO_3$)	206.	
Alkalinity (as $CaCO_3$)	310.	

Total Solids	ppm	360.	epm
Conduct. at 25°C	lab	646.	field
pH	lab	8.3	field
Cation: Anion Balance			8.55 %
Total Solids Balance			2.17 %

LITHOLOGY

Comments:

Identification No. Altitude 3450'
¼ or LSD E½
Sec. 28
Tp. 13 R. 28
Mer. 4
Co-ordinates
Map Sheet No. 82I/4W
CHEM ANALYSIS Contents

(2)

Alberta ENVIRONMENT
Earth Sciences and Licensing Division

WATER WELL DRILLERS REPORT

① WELL CONTRACTOR

Hi Rate Drilling & Ltd
Address Stettler
Alta

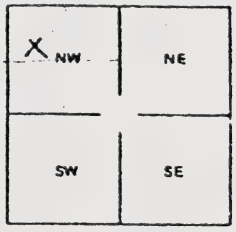
② WELL OWNER

Dept of Rec. Parks & Wildlife
Address Parks Division
Willow Creek Park.

③ LOCATION

¼	Sec.	Twp.	Rge.	West of Meridian
SD 11	28	13	28	4

Mark Well location with an "X" in diagram below



1 SQUARE MILE

④ Date started Oct 6 19 76
Date completed Oct 7 19 76

⑤ TYPE OF WELL:
Rotary ☑ Bored ☐ Cable tool ☐
Jet ☐ Dug ☐ Other ☐

⑥ TYPE OF WORK:
New Well ☑ Deepen ☐
Recondition ☐ Abandon ☐

⑦ PROPOSED USE:
Domestic ☑ Stock ☐ Irrigation ☐
Municipal ☐ Industrial ☐ Test ☐

⑧ FORMATION LOG DESCRIPTION

Depth in Feet from	Depth in Feet to	Use key to formation
Ground Level	1	fill
1	11	gravel
11	17	shale soft hard
17	58	Sandstone water 54-58

⑨ WELL COMPLETION DATA

DESIGN:
Open hole ☐ Slotted casing ☑
Screen ☐ Gravel pack ☐
Diameter of hole: 6 5/8
Bottomed in: Clay ☐ Sand ☐
Sandstone ☐ Shale ☑ Coal ☐
Depth to top of bedrock: 11
Total depth: 58'

⑩ CASING:
Type: Steel
Size O. D. 5 5/8 Wall thickness: .156
Wt. per ft.
Bottom set at: 40 ft.

⑪ SEAL: Yes ☑ No ☐
Packer ☐ Grout ☐ Driven ☑
Loose ☐ Puddled clay ☐
Depth of seal: 40

⑫ LINER: Yes ☑ No ☐
Type: Steel
Size O.D. 4 1/2 I. D.
Weight: 14# lbs.
Bottom set at: 58' ft.
Perforated from: 53 ft. to 58 ft.
How perforated: Knife ☐
Torch ☑ Machine ☐
Size perforations: 1/2 in. by 12 in.

⑬ SCREEN: Yes ☐ No ☑
Make:
Material:
Size I. D. (clear):
Length:
Slot size:
Top at: Bottom at:
Fittings top.
Fittings bottom.

⑭ SAND PACK: Yes ☐ No ☑
Size Amount.

⑮ PUMP: Yes ☐ No ☑
Type H. P.
Size Voltage
Drop pipe size Length
Intake at

⑯ ELECTRIC LOG: Yes ☐ No ☑
Gamma ☐ Electric ☐

⑰ WATER QUALITY:

Hard ☐ Medium Hard ☐
Soft ☐ Turbid ☑
Chemical Analysis: Yes ☐ No ☐
Bacterial Analysis: Yes ☐ No ☐

Air 15-20 gpm

⑱ WATER TEST:

Pump ☐ Bailer ☐
Static water level 44.39 (AFTER DEVELOPMENT)
Rate of yield: I. G. P. M.
Duration of test: hrs. min.
Pumping level or bailing level:
Total drawdown:
Recommended pump setting:
(Attach readings of any detailed pump tests)

CERTIFICATION

⑲ WATER WELL DRILLER (operator)

This well was constructed under my direct supervision and all information given is true to the best of my knowledge and belief.
A copy of this report has been supplied to the owner.
Signature: Allen Kirby
Date: Oct 7 19 76

THIS REPORT TO BE SUBMITTED WITHIN 60 DAYS AFTER WELL COMPLETION, TO:
CONTROLLER OF WATER RESOURCES
ALBERTA ENVIRONMENT
MINES BUILDING EDMONTON

Michale's Water & Soil Service

September 1, 1969

September 21, 1969

Willow Creek Prov. Park
Well #2

68-9192

340

122

233

21

4

29

Bicarbonate of lime, magnesium, soda

nil

nil

0.89

Water is chemically suitable for human consumption after iron settles.

Kathleen I. Strasser (Mrs.)

Kitimat

COPY

(4)

ITEM	STANDARD OF MEASUREMENT	SAMPLE TAKEN Sample (A)	Sample (B)	DIFFERENCE (A) (B)
Temperature	Degrees F.	55.6°	55.6°	
pH	To Tenths	6.8	6.8	
Alkalinity	PPM	413	413	
Odor	Type	0	0	
Total Solids	PPM		580	32
Turbidity	PPM S_1O_2	2	2	
Hardness	PPM	372	372	
Chlorides	PPM	2	2	
Nitrite	PPM	0	0	
Nitrate	PPM	0	0.25	0.26
Sulphate	PPM	33	33	
Phosphate	PPM	0	0	
Color	Unit	1	1	
Phenolics	UG/L	0	0	
Oil and Grease	MG/L	0	0	
Iron	PPM	2.5	2.3	.2
Manganese	PPM	0	0	
Bacteriological	E.Coli/Liter	0	0	
	Plate Count	140	140	
Date Sampled		June 9/68	Oct. 2/69	
Time Sampled		2:00 p.m.	4:00 p.m.	
Location of Sample		Wells	Wells	
Depth of Sample		50 Feet	50 Feet	
Type of Sample		Composite	Composite	

Comments: Water quality is good. Iron requires treatment. Nitrate result of intrusion of surface runoff.

Map Sheet No. 82-I Contents FLOWING SHOT HOLE

Co-ordinates 3255 's 3420 'w Altitude 3436

Mer. 4 Tp. 13 R. 28 Sec. 33 ¼ or LSD SW-4 Identification No.

FIELD OBSERVATIONS:

Type of observation ..... Date .....

Comments: .....

.....

.....

Observed by: .....

WELL AND BOREHOLE DATA

Owner Shaples Oil Co. Address Calgary Date .....

Driller ..... Type of Rig .....

Completed Depth of Well .....

Water-Bearing Intervals		Depth to Water
From	to	.....
From 20	to	.....
From	to	.....
From	to	.....

Well Construction

(a) Slotted casing From ..... to .....
(b) Open hole From ..... to .....
(c) Screen From ..... to .....
(d) Dug
(e) Bored

Depth to water in Finished Well

AQUIFER TESTS

Test rate ..... igpm

Transmissivity { Apparent ..... / Bail Test ..... / Pump Test ..... / Recovery ..... / Equivalent .....

Original available drawdown .....

Q_w, from pump test .....
(estimated well yield)

Storage Coeff. ..... at r_1 .....
..... at r_2 .....
..... at r_3 .....

CHEMISTRY

	ppm		%
Total solids	.....	Mg	.....
Hardness	.....	Ca	.....
Ca	.....	Ca+Mg	.....
Mg	.....	Na+K	.....
Sulfates(SO_4)	.....	Chlorides	.....
Chlorides	.....	CO_3+HCO_3	.....
CO_3+HCO_3	.....	SO_4	.....
Alkalinity	.....		
Nitrate (NO_3)	.....		
Iron	.....		
Fluorine	.....		

Comments: .....

.....

.....

.....

.....

LITHOLOGY

.....

.....

.....

.....

(6)

Map Sheet No. 82 - I/4 E Contents CHEM ANALYSIS Accuracy is...

Mer. 4 Tp. 13 R. 28 Sec. 34 ¼ or LSD NW Identification No.

Co-ordinates 82 I/4 E Altitude 3500'

FIELD OBSERVATIONS:

Type of observation ..... Date .....

Comments: .....

Observed by: .....

WELL AND BOREHOLE DATA

Owner R. Duncan Address Stavely Date Aug/1963

Driller ..... Type of Rig .....

Completed Depth of Well 200'

Water-Bearing Intervals		Depth to Water
From	to	
From	to	
From	to	
From	to	

Well Construction

(a) Slotted casing From ..... to .....
(b) Open hole From ..... to .....
(c) Screen From ..... to .....
(d) Dug
(e) Bored

Depth to water in Finished Well 60' (3440')

AQUIFER TESTS

Test rate ..... igpm

Transmissivity { Apparent ..... Bail Test ..... Pump Test ..... Recovery ..... Equivalent .....

Original available drawdown .....

Q_{ss}, from pump test ..... (estimated well yield)

Storage Coeff. ..... at r_1 .....
..... at r_2 .....
..... at r_3 .....

CHEMISTRY Aug 63

	p.p.m.		%
Total solids	920	Mg	
Hardness	30	Ca	
Ca		Ca+Mg	4.4
Mg		Na+K	96.
Sulfates(SO_4)	95	Chlorides	7.6
Chlorides	37	CO_3+HCO_3	78.
CO_3+HCO_3		SO_4	14.
Alkalinity	535		
Nitrate (NO_3)	nil		
Iron	2.0		
Fluorine			

Soda = 37.5 gr/gal.

Comments:

Water is chem. suitable when Iron settles.

Soda will corrode alum + harm plants.

LITHOLOGY

STRAT.

(7)

Alberta
ENVIRONMENT
Earth Sciences and Licensing Division

WATER WELL DRILLERS REPORT

(1) WELL CONTRACTOR

NIEMANS DRILLING LTD
Address BOX 142
HIGH RIVER
ALTA.

(2) Date started SEPT. 27 19 77
Date completed OCT. 3 19 77

(3) TYPE OF WELL:
Rotary X Bored ☐ Cable tool ☐
Jet ☐ Dug ☐ Other ☐

(4) TYPE OF WORK:
New Well X Deepen ☐
Recondition ☐ Abandon ☐

(5) PROPOSED USE:
Domestic X Stock X Irrigation ☐
Municipal ☐ Industrial ☐ Test ☐

(6) FORMATION LOG DESCRIPTION

Depth in Feet from	Depth in Feet to	Use key to formation
Ground Level	46	SANDY CLAY
		SAND & GRAVEL
46	91	SHALE
91	95	SHALE + SAND-STONE (1½-2 G.P.M.)
95	198	SHALE + A FEW THIN SANDSTONE LEDGES
198	250	SANDSTONE

(7) ELECTRIC LOG: Yes ☐ No X
Gamma ☐ Electric ☐

C Jan/75

(8) WELL OWNER

DAVE GRAHAM
Address BOX 264
STAVELY
ALTA.

(9) WELL COMPLETION DATA

DESIGN:
Open hole ☐ Slotted casing X
Screen ☐ Gravel pack ☐
Diameter of hole 5⅞
Borehole in: Clay ☐ Sand ☐
Sandstone X Shale ☐ Coal ☐
Depth to top of bedrock: 46
Total depth 246

(10) CASING:
Type STEEL I.J.
Size O.D. 4½ Wall thickness: .188
Wt. per ft. 13
Bottom set at 191½ ft.

(11) SEAL: Yes X No ☐
Packer ☐ Grout ☐ Driven X
Loose ☐ Puddled clay ☐
Depth of seal: 19 + 46'
(rubber plug)

(12) LINER: Yes X No ☐
Type: I.J. STEEL
Size O.D. 4½ I.D. 4¼
Weight 6.½ lbs
Bottom set at 246 ft.
Perforated from 200 ft. to 240 ft.
How perforated 90 Knife 98
Torch X Machine ☐
Size perforations: ⅛ in. by 10 in.

(13) SCREEN: Yes ☐ No X
Make:
Material:
Size I.D. (clear):
Length:
Slot size:
Top at: Bottom at:
Fittings top:
Fittings bottom:

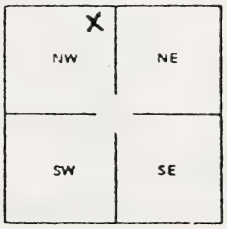
(14) SAND PACK: Yes ☐ No X
Size Amount

(15) PUMP: Yes ☐ No X
Type: H.P.
Size: Voltage
Drop pipe size: Length:
Intake at:

(16) LOCATION

¼	Sec.	Twp.	Rge.	West of Meridian
NW	34	13	28	4

Mark Well location with an "X" in diagram below



1 SQUARE MILE

(17) WATER QUALITY

Hard ☐ Medium Hard ☐
Soft ☐ Turbid ☐
Chemical Analysis: Yes ☐ 775 No X
Bacterial Analysis: Yes ☐ 326 No X
775
26

(18) WATER TEST:

Pump X AIR Bailer ☐
Static water level 65
Rate of yield: 7½-8 I.G.P.M.
Duration of test: 3 hrs. — min.
Pumping level or bailing level 240
Total drawdown:
Recommended pump setting 230-235
(Attach readings of any detailed pump tests)

CERTIFICATION

(19) WATER WELL DRILLER (operator)

This well was constructed under my direct supervision and all information given is true to the best of my knowledge and belief.
A copy of this report has been supplied to the owner.
Signature: Peter Niemans
Date: SEPT OCT. 3 19 77

THIS REPORT TO BE SUBMITTED WITHIN 60 DAYS AFTER WELL COMPLETION, TO:
CONTROLLER OF WATER RESOURCES
ALBERTA ENVIRONMENT
MILNER BUILDING, EDMONTON

POLLUTION CONTROL DIVISION
LABORATORY
P.O. BOX 489
EDMONTON, ALBERTA
T5J 2X1

Alberta
ENVIRONMENT

Lab. No. 11560

CHEMICAL WATER ANALYSIS REQUEST

(For Water Intended For Human Consumption)

Routine Analysis ☑
F only ☐
NO_3+f only ☐
Other .....

Location of Sample:

David Graham
(NAME) (ADDRESS) (CITY, TOWN, VILLAGE)

(TELEPHONE)

☑ Private Supply
☐ Public Supply

Location NW ¼ Section 34 Township 13 Range 28 W 4 Meridian

Submitted by: Chinook Health Unit Phone .....
Fort Macleod
(ADDRESS)

Results to: Health Unit ☑
Above ☐ or .....

Date Sampled: Oct 22

Source of Sample: Tap
(NAME OF STREAM, DUGOUT, WELL, TAP, ETC.)

Well ☑ Depth 255 feet, Depth to Water Level 16.6 feet.

Well Completion drilled
(DRILLED, DUG, SCREENED, ETC.)

Reason for Sample: ☑ To Determine Suitability for Drinking Purposes

Other (Specify) .....

PC 1

Sampled by J. Singh

CHEM. ANALYSIS REPORT

LOCATION : GRAHAM D. CHIN

LAB NO. 11560-W DATE REC D 27/10/77 DATE COMPLETED 4/11/77

PARAMETER	CODE	MG/L	PARAMETER	CODE	MG/L
PH	10301L	8.6	CONDUCTIVITY	02041L	1350.
CALCIUM	20105L	33.	MAGNESIUM	12102L	22.
SODIUM	11103L	388.	POTASSIUM	19103L	3.2
IRON	26302L	0.1*	SILICA	14102L	9.4
NO2 + NO3	07105L	5.2	NITRITE	07205L	0.1*
CHLORIDE	17203L	30.	SULFATE	16305L	424.
FLUORIDE	09107L	1.46	CARBONATE	06301L	6.
BICARBONATE	06201L	516.	HARDNESS T	10604L	173.
ALKALINITY T	10101L	432.	TDS	00205L	1183.

BALANCE 1.09

* INDICATES CONCENTRATION LESS THAN . CONDUCTIVITY REPORTED IN MICROSIEMENS/CM. PH IN PH UNITS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRITE EXPRESSED AS N.

TDS = TOTAL DISSOLVED SOLIDS
NO2 = NITRITE
NO3 = NITRATE

CERTIFIED ..... FOR
W.E. KORTSCH, HEAD, LABORATORY
POLLUTION CONTROL DIVISION

Mer. 4 Tp. 13 R. 28 Sec. 34 ¼ or LSD N.W. Identification No.

Altitude 3500'

Map Sheet No. 82-H/4W Co-ordinates

Contents CHEM ANALYSIS

FIELD OBSERVATIONS:

Type of observation ..... Date

Comments:

Observed by:

WELL AND BOREHOLE DATA

Owner D. Graham Address STAVELY Date

Driller Type of Rig drilled

Completed Depth of Well 160

Water-Bearing Intervals		Depth to Water	Well Construction		
From	to		(a) Slotted casing	From	to
From	to		(b) Open hole	From	to
From	to		(c) Screen	From	to
From	to		(d) Dug		
			(e) Bored		

Depth to water in Finished Well 60 Water Temp. F C

AQUIFER TESTS

Type	Transmissivity	Q	Test rate igpm. for min
Pump Test			Total Drawdown
Bail Test			Original available drawdown
Recovery Test			Storage Coeff. at r,
Apparent-Yield Test			at r
			at r

CHEMISTRY 28-177	ppm	epm %	LITHOLOGY
Calcium	9	3	
Magnesium	3	2	
Sodium	250	93	
Potassium	0.8	~~6~~.2	
Iron	0.07	—	
Nitrate (NO_3)	<.45	—	
Chloride	40	9	
Sulfate (SO_4)	130	~~6~~ 22	
Fluoride	<.05	—	
Carbonate (CO_3)	25	6	
Bicarbonate (HCO_3)	454	61	
Silica (H_4SiO_4)			
Hardness (as $CaCO_3$)	35		
Alkalinity (as $CaCO_3$)	414		

Total Solids	ppm	685	epm	
Conduct. at 25°C	lab	1200	field	
pH	lab	8.9	field	
Cation: Anion Balance			4.4	%
Total Solids Balance				%

Comments:

(8)

WATER WELL DRILLERS REPORT

Alberta ENVIRONMENT

24456

THIS REPORT TO BE SUBMITTED WITHIN 60 DAYS AFTER WELL COMPLETION, TO:

DIRECTOR OF EARTH SCIENCES ALBERTA ENVIRONMENT

WELL CONTRACTOR

TRANS PROVINCIAL DRILLING
Address Box 755
CLARESHOLM ALBERTA

License No 146
Permit No
Date started JUNE 2 19 83
Date completed JUNE 6 19 83

TYPE OF WELL:
Rotary ☑ Bored ☐ Cable tool ☐
Jet ☐ Dug ☐ Other ☐

TYPE OF WORK
New Well ☐ Deepen ☐
Recondition ☐ Abandon ☐

PROPOSED USE:
Domestic ☑ Stock ☐ Irrigation ☐
Municipal ☐ Industrial ☐ Test ☐

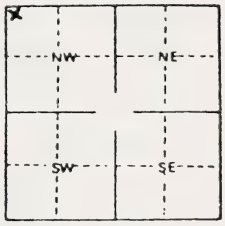
WELL OWNER

Brenda Rasmussen
Address Box 1665
Claresholm, Alta.

LOCATION

¼	Sec.	Twp.	Rge.	West of Meridian
NW	35	13	28	4th

Mark Well location with an "X" in diagram below



1 SQUARE MILE

WELL COMPLETION DATA

DESIGN:
Open hole ☐ Slotted casing ☑
Screen ☐ Gravel pack ☐
Diameter of hole: 6"
Bottomed in: Clay ☐ Sand ☐
Sandstone ☑ Shale ☐ Coal ☐
Depth to top of bedrock 50
Total depth 135

CASING:
Type: STEEL
Size O.D. 6⅝ Wall thickness: ¼
Wt. per ft.
Bottom set at 50 ft.

SEAL: Yes ☑ No ☐
Packer ☐ Grout ☐ Driven ☑
Loose ☐ Puddled clay ☐
Depth of seal 50 ft

LINER: Yes ☑ No ☐
Type: PLASTIC
Size O.D. 4½ I.D. 4"
Weight: lbs.
Bottom at 128 Top at 8 ft
Perforated from: 40 ft. to 120 ft.
How perforated: Knife ☑
Torch ☐ Machine ☐
Size perforations ⅛ in. by 1 in.

SCREEN: Yes ☐ No ☑
Make:
Material
Size I.D. (clear)
Length
Slot size
Top at Bottom at
Fittings top
Fittings bottom

SAND PACK: Yes ☐ No ☑
Size Amount

PUMP: Yes ☐ No ☑
Type H.P.
Size Voltage
Drop pipe size Length
Intake at

WATER QUALITY:

Hard ☐ Medium Hard ☑
Soft ☐ Turbid ☐
Chemical Analysis: Yes ☑ No ☐
Bacterial Analysis: Yes ☐ No ☐

WATER TEST:

Pump ☐ Bailer ☐
Static water level 40 ft
Rate of yield 40 I.G.P.M.
Duration of test: 8 hrs. mm.
Pumping level or bailing level:
Total drawdown at end of test
Pump setting ft 115 I.G.P.M.
Additional Yield Test Information Attached Yes ☐ No ☑

FORMATION LOG DESCRIPTION

Depth in Feet from	to	Use key to formation
Ground Level	40	SAND CLAY + gravel
40	135	SAND STONE

ELECTRIC LOG: Yes ☐ No ☑
Gamma Induction Sonic

CERTIFICATION

WATER WELL DRILLER (operator)

This well was constructed under my direct supervision and all information given is true to the best of my knowledge and belief.
A copy of this report has been supplied to the owner.

Signature Walter Hill
Date 19

WELL OWNER

Anticipated Use gal per day
I have received a copy of this report
Signature Brenda Rasmussen
Date June 27 19 83

Alberta Environment Copy

FORM C 81 82

105

Alberta ENVIRONMENT

ENVIRONMENTAL PROTECTION SERVICES
EARTH SCIENCES DIVISION
TECHNICAL DEVELOPMENT BRANCH
COUSINS BUILDING, LETHBRIDGE, ALBERTA
T1J 4B3 PHONE: 329-5322

(8)

CHEMICAL WATER ANALYSIS REQUEST

Lab. No. .....

Date Rec'd .....

Project Code No. .....

History

Location of Sample: Brenda Rasmussen (NAME) Box 665 (STREET) Claresholm (CITY, TOWN, VILLAGE)

..... (TELEPHONE)

NB* Location NW ¼ Section 35 Township 13 Range 28 W 4M Meridian

Source of Sample: well (STREAM, DUGOUT, WELL, TAP, ETC.)

NB* Well ☐ Depth 125 feet, Depth to Water Level 100 feet.

Well Completion ..... (DRILLED, DUG, SCREEN, SETTLING ETC.)

Submitted by: ..... Phone .....

..... (ADDRESS)

Results to: Above ☐ or .....

Date of Sample: ..... Sampler's Comments: .....

Reason for Sample: HUMAN CONSUMPTION ☐ For Interpretation Contact Local Health Unit

LIVESTOCK CONSUMPTION ☐ For Interpretation Contact Local Veterinarian

IRRIGATION ☐ For Interpretation Contact Irrigation Specialist

CHEMICAL WATER ANALYSIS REPORT

Analysis:

Date Completed 83

pH 8.2

EC ..... 0.40 m Siemens/cm

SAR 2.01

	Sample Results mg/L (ppm)	Canadian Drinking Water Standards mg/L (ppm)	
Calcium		N.E.*	Ca
Magnesium		150	Mg
Hardness, Total		500	$CaCO_3$
Sodium		300	Na
Potassium		N.E.	K
Carbonate		N.E.	CO_3
Bicarbonate		N.E.	HCO_3
Alkalinity, Total (T. Alk.)	183	500	$CaCO_3$

	Sample Results mg/L (ppm)	Canadian Drinking Water Standards mg/L (ppm)	
Iron		0.3	Fe
Fluoride	0.22	1.5	F
Sulphate	55	500	SO_4
Chloride	4	250	Cl
Nitrate-Nitrogen Plus Nitrite-Nitrogen	<0.05	10.0	N
Ammonium-N	0.20		
Total Dissolved Solids (TDS)	265	1000	

Laboratory Comments

(4)

Mer. 4 Tp. 13 R. 28 Sec. 35 ¼ or LSD 12 Identification No.

Co-ordinates Altitude

Map Sheet No. 82I Contents CHEM ANALYSIS

FIELD OBSERVATIONS:

Type of observation ..... Date .....

Comments: .....

Observed by: .....

WELL AND BOREHOLE DATA

Owner ..... Address ..... Date .....

Driller ..... Type of Rig .....

Completed Depth of Well .....

Water-Bearing Intervals		Depth to Water
From	to	
From	to	
From	to	
From	to	

Well Construction

(a) Slotted casing From ..... to .....
(b) Open hole From ..... to .....
(c) Screen From ..... to .....
(d) Dug
(e) Bored

Depth to water in Finished Well .....

AQUIFER TESTS

Test rate ..... igpm

Transmissivity { Apparent ..... Bail Test ..... Pump Test ..... Recovery ..... Equivalent .....

Original available drawdown .....

Q_w, from pump test .....
(estimated well yield)

Storage Coeff. ..... at r_1 .....
..... at r_2 .....
..... at r_3 .....

CHEMISTRY (Dec. 1970)

	ppm		%
Total solids	736	Mg	
Hardness	34	Ca	
Ca		Ca+Mg	6
Mg		Na+K	94
Sulfates(SO_4)	273	Chlorides	3
Chlorides	12	CO_3+HCO_3	49
CO_3+HCO_3		SO_4	49
Alkalinity	285		
Nitrate (NO_3)	—		
Iron	0.04		
Fluorine	4.10		

Comments: .....

LITHOLOGY

STRAT.

(10)

Alberta
ENVIRONMENTAL CENTRE

CHEMICAL ANALYSIS REQUEST
DRINKING WATER FOR HUMAN CONSUMPTION

Lab. No. 13,448

- [x] Routine Analysis
- [ ] Fluoride (only)
- [ ] Nitrate (only)
- [ ] Other

Source of Sample VENLY S BROWN
(name) P.O. Box 1934, (address) CLARESHOLM, (city, town, village) AB (postal code) (telephone)

- [x] Private
- [ ] Public Supply

Location NE ¼ Section 35 Township 13 Range 28 W 4 Meridian

Well [x] Depth 100 Feet Tap [ ]

Other (identify)

Date Sampled Nov 4, 82 Sampled by VB

Submitted by Chinook Health Unit
Box 127
Fort Macleod, Alberta T0L 0Z
(address) Phone

Health Unit to Receive Results

Please See Reverse Side for Additional Information

CHEM. ANALYSIS REPORT

LOCATION : BROWN V OF

LAB NO. 13448-W DATE REC'D 12/11/82 DATE COMPLETED 29/11/82

PARAMETER	CODE	MG/L	PARAMETER	CODE	MG/L
PH	10301L	8.6	CONDUCTIVITY	02041L	[illegible]
IRON	26304L	0.12	TDS	00205	[illegible]
CALCIUM	20110L	41.	MAGNESIUM	12306L	[illegible]
HARDNESS T	10602L	172.	SODIUM	11103L	190.
POTASSIUM	19103L	3.2	SILICA	14102L	8.2
NO2 + NO3	07105L	0.25	NITRITE	07205L	0.05*
FLUORIDE	09107L	0.46	CHLORIDE	17203L	4.
SULFATE	16306L	275.	BICARBONATE	06201L	418.
CARBONATE	06301L	14.	ALKALINITY T	10101L	367.

SUM OF CATIONS 11.79 SUM OF ANIONS 13.21

BALANCE 0.89

* INDICATES CONCENTRATION LESS THAN . CONDUCTIVITY REPORTED IN MICROSIEMENS/CM, PH IN PH UNITS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRITE AND NITRATE + NITRITE EXPRESSED AS N.

******* NOTE: NO VALUE
TDS - TOTAL DISSOLVED SOLIDS
NO2 = NITRITE
NO3 = NITRATE

CERTIFIED.....FOR
DR. E.P. DICKEN, HEAD, WATER ANALYSIS &
RESEARCH SECTION, CHEMISTRY WING
ALBERTA ENVIRONMENTAL CENTRE

FORM E S (LAB) 1

Alberta
ENVIRONMENT

ENVIRONMENTAL PROTECTION SERVICES
EARTH SCIENCES DIVISION
TECHNICAL DEVELOPMENT BRANCH
COUSINS BUILDING, LETHBRIDGE, ALBERTA
T1J 4B3 PHONE 329-5322

CHEMICAL WATER ANALYSIS REQUEST

Lab. No. 1446
Date Rec'd Oct 28/82
Project Code No. 2

History

Location of Sample: Wendy Brown (NAME) Stauxly (STREET) Alta (CITY, TOWN, VILLAGE)

NB* Location NE ¼ Section 36 Township 13 Range 28 W 04 (TELEPHONE) Meridian

Source of Sample (STREAM, DUGOUT, WELL, TAP, ETC.)

NB* Well ☒ Depth 100 feet, Depth to Water Level 37 feet.

Well Completion drilled about 1927 (DRILLED, DUG, SCREEN, SETTLING ETC.)

Submitted by: AC Strauss Phone

1400 Rocky Mtn Plaza CALGARY (ADDRESS)

Results to: Above ☐ or

Date of Sample: 26/10/82 Sampler's Comments:

Reason for Sample:
HUMAN CONSUMPTION ☐ For Interpretation Contact Local Health Unit
LIVESTOCK CONSUMPTION ☐ For Interpretation Contact Local Veterinarian
IRRIGATION ☐ For Interpretation Contact Irrigation Specialist

CHEMICAL WATER ANALYSIS REPORT

Analysis

Date Completed 82

pH 8.3

EC 1.14 m Siemens/cm

SAR 6.67

	Sample Results mg/L (ppm)	Canadian Drinking Water Standards mg/L (ppm)			Sample Results mg/L (ppm)	Canadian Drinking Water Standards mg/L (ppm)	
Calcium	45	N.E.*	Ca	Iron	0.48	0.3	Fe
Magnesium	19	150	Mg	Fluoride	0.41	1.5	F
Hardness, Total	190	500	$CaCO_3$	Sulphate	30.2	500	SO_4
Sodium	212	300	Na	Chloride	2	250	Cl
Potassium	3	N.E.	K	Nitrate-Nitrogen Plus Nitrite-Nitrogen	<0.05	10.0	N
Carbonate	0	N.E.	CO_3				
Bicarbonate	447	N.E.	HCO_3		<0.05		
Alkalinity, Total (T. Alk.)	366	500	$CaCO_3$	Total Dissolved Solids (TDS)	677	1000	
	0.24						

POLLUTION CONTROL DIVISION
LABORATORY
P.O. BOX 399
EDMONTON, ALBERTA
T5J 2K1

6419

PLEASE RUSH !!

Alberta ENVIRONMENT

CHEMICAL WATER ANALYSIS REQUEST

(For Water Intended For Human Consumption)

Routine Analysis ☑
F only ☐
NO_3 + F only ☐
Other .....

Location of Sample:

(TREATED) (NAME) Larry Brown (ADDRESS) Bx 83 Chin (CITY, TOWN, VILLAGE) 223-2265 (TELEPHONE)

☑ Private Supply
☐ Public Supply

Location NE ¼ Section 35 Township 13 Range 28 W 4 Meridian

Submitted by: Christine Hall Lot 23, 727 - 7A Street Phone 328-4151
(ADDRESS)

For Health Unit ....

Above ☐ or ....

Date Sampled: June 27/77

Source of Sample: .... (NAME OF STREAM, DUGOUT, WELL, TAP, ETC.)

Well #1 Depth 100 feet, Depth to Water Level 15 feet.

Well Completion: drilled (DRILLED, DUG, SCREENED, ETC.)

Reason for Sample: ☑ To Determine Suitability for Human Purposes

Other (Specify) ....

For ....

Sampled by Larry Brown

CHEM. ANALYSIS REPORT

LOCATION : BROWN V. 1 CHIN

LAB NO. 6419-W DATE REC'D 27/06/77 DATE COMPLETED 5/ 7/77

PARAMETER	CODE	MG/L	PARAMETER	CODE	MG/L
PH	10301L	8.5	CONDUCTIVITY	02041L	1960.
CALCIUM	20105L	5.	MAGNESIUM	12102L	4.
SODIUM	11103L	426.	POTASSIUM	19103L	2.4
IRON	26302L	0.56	SILICA	14102L	16.6
NO2 + NO3	07105L	0.1*	NITRITE	07205L	0.1*
CHLORIDE	17203L	185.	SULFATE	16306L	279.
FLUORIDE	09107L	0.38	CARBONATE	06301L	5.*
BICARBONATE	06201L	475.	HARDNESS T	10604L	29.
ALKALINITY T	10101L	398.	TDS	00205L	1139.

BALANCE 1.01

* INDICATES CONCENTRATION LESS THAN . CONDUCTIVITY REPORTED IN MICROSIEMENS/CM. PH IN PH UNITS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRITE AND NITRATE + NITRITE EXPRESSED AS N.

TDS - TOTAL DISSOLVED SOLIDS
NO2 = NITRITE
NO3 = NITRATE

CERTIFIED .....EUR
W.E. KORTSCH, HEAD, LABORATORY
POLLUTION CONTROL DIVISION
ALBERTA ENVIRONMENT

(11)

POLLUTION CONTROL DIVISION
LABORATORY
P.O. BOX 469
EDMONTON, ALBERTA
T5J 2K1

Alberta ENVIRONMENT

Lab. No. 6488

CHEMICAL WATER ANALYSIS REQUEST

(For Water Intended For Human Consumption)

Routine Analysis. ☑
F only ☐
NO_3+F only ☐
Other .....

Location of Sample: Mr. BERT NELSON
(NAME) P.O Box 241, (ADDRESS) STAVELY, (CITY, TOWN, VILLAGE) ALTA (TELEPHONE)

☑ Private Supply
☐ Public Supply

Location NE ¼ Section 2 Township 14 Range 28 W 4 Meridian

Submitted by: [illegible] Health Unit Phone .....
Box 777
Fort Macleod, Alta. TOL 0Z0
(ADDRESS)

Results to: Health Unit ✓
Above ☐ or .....

Date Sampled: 4-6-80

Source of Sample: well (yard)
(NAME OF STREAM, DUGOUT, WELL, TAP, ETC.)

Well ☑ Depth 180 feet, Depth to Water Level ..... feet.

Well Completion Drilled
(DRILLED, DUG, SCREENED, ETC.)

Reason for Sample: ☑ To Determine Suitability for Drinking Purposes
Other (Specify) .....

PC-1

Sampled by [signature]

CHEM. ANALYSIS REPORT

LOCATION : NELSON B. CH

LAB NO. 6488-W DATE REC'D 17/06/80 DATE COMPLETED 24/ 6/80

PARAMETER	CODE	MG/L	PARAMETER	CODE	MG/L
PH	10301L	9.1	CONDUCTIVITY	02041L	1295.
IRON	26304L	0.04	TDS	00205L	752.
CALCIUM	20105L	8.	MAGNESIUM	12303L	5.
HARDNESS T	10604L	42.	SODIUM	11103L	268.
POTASSIUM	19103L	1.2	SILICA	14102L	6.7
NO2 + NO3	07105L	0.05*	NITRITE	07205L	0.05*
FLUORIDE	09107L	4.42	CHLORIDE	17203L	23.
SULFATE	16306L	200.	BICARBONATE	06201L	409.
CARBONATE	06301L	45.	ALKALINITY T	10101L	411.

SUM OF CATIONS 12.52 SUM OF ANIONS 13.26

BALANCE 0.94

* INDICATES CONCENTRATION LESS THAN . CONDUCTIVITY REPORTED IN MICROSIEMENS/CM. PH IN PH UNITS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRITE AND NITRATE + NITRITE EXPRESSED AS N.

****** NOTE: NO VALUE
TDS = TOTAL DISSOLVED SOLIDS
NO2 = NITRITE
NO3 = NITRATE

CERTIFIED A.W FOR
W.E. KORTSCH, HEAD, LABORATORY
POLLUTION CONTROL DIVISION
ALBERTA ENVIRONMENT

(11)

FIELD OBSERVATIONS:

Type of Observation ..... Date .....

Comments .....

Observed by: .....

WELL DATA

Owner ..... Date drilled

Address .....

Well Construction

Total casing From ..... to .....

Open hole From ..... to .....

Screen From ..... to .....

Depth .....

Type of Completed Well .....

AQUIFER DATA

Test .....

Transmissibility .....

Storage Coeff. .....

Recharge .....

Boundary .....

Specific Capacity .....

Maximum available drawdown .....

Recommended pump test .....

Safe well yield) .....

Coeff. at r. .....

at r. .....

at r. .....

CHEMISTRY

Total solids		Ca	
Hardness		Mg	
Fe		Na+K	
SiO$_2$		CO_3+HCO_3	
SO_4		Chlorides	
NO$_3$		CO_3+HCO_3	
		SO_4	

LITHOLOGY STRAT.

Remarks .....

Chemist .....

(11)

Map Sheet No. 82-I/4E Contents CHEM ANALYSIS

Coordinates Altitude 3440

Mer. 4 Tp. 14 R. 28 Sec. 2 ¼ or LSD NW Identification No. L11

FIELD OBSERVATIONS:

Type of observation ..... Date .....

Comments: .....

Observed by: .....

WELL AND BOREHOLE DATA

Owner Bert Nelson Address Stavely Date 1970

Driller ..... Type of Rig .....

Completed Depth of Well 220'

Water-Bearing Intervals		Depth to Water	Well Construction		
From	to	ground 130'	(a) Slotted casing	From	to
From	to	" 170'	(b) Open hole	From	to
From	to		(c) Screen	From	to
From	to		(d) Dug		
			(e) Bored		

Depth to water in Finished Well 60-80'

AQUIFER TESTS

Test rate ..... igpm

Original available drawdown .....

Transmissivity { Apparent ..... Bail Test ..... Pump Test ..... Recovery ..... Equivalent .....

Q_w, from pump test ..... (estimated well yield)

Storage Coeff. ..... at r_1 .....

..... at r_2 .....

..... at r_3 .....

CHEMISTRY 31-12-70

	ppm		%
Total solids	640	Mg	
Hardness	57	Ca	
Ca		Ca+Mg	6
Mg		Na+K	94
Sulfates(SO_4)	79	Chlorides	8
Chlorides	34	CO_3+HCO_3	78
CO_3+HCO_3		SO_4	14
Alkalinity	453		
Nitrate (NO_3)	nil		
Iron	0.3		
Fluorine	5.15		

Na/HCO_3

Comments: section mostly shale

LITHOLOGY STRAT.

(12)

Alberta
ENVIRONMENT
Earth Sciences and Licensing Division

WATER WELL DRILLERS REPORT

① WELL CONTRACTOR

NIEMANS DRILLING LTD
Address Box 142
HIGH RIVER
ALTA.

③ Date started DEC. 14 19 77
Date completed " 19 77

⑤ TYPE OF WELL: Rotary X Bored ☐ Cable tool ☐ Jet ☐ Dug ☐ Other ☐

⑥ TYPE OF WORK: New well X Deepen ☐ Reconditioned ☐ Abandon ☐

⑦ PROPOSED USE: Domestic X Stock X Irrigation ☐ Municipal ☐ Industrial ☐ Test ☐

⑧ FORMATION LOG DESCRIPTION

Depth in Feet from	to	Use key to formation
Ground Level	29	BROWN SANDY CLAY + ROCKS
29	79	BLUE CLAY + ROCKS
79	104	SOFT SHALE
104	115	SANDSTONE
115	146	SHALE + S.S.
146	168	SANDSTONE
		(Water)
168	180	SHALE + S.S.
180	188	SHALE

⑨ ELECTRIC LOG: Yes ☐ No X
Schlumberger ☐ Electric ☐

② WELL OWNER

BERT NELSON
Address Box 241
STAVELY
ALTA

⑨ WELL COMPLETION DATA

DESIGN:
Open hole ☐ Slotted casing X
Screen ☐ Gravel pack ☐
Diameter of hole 5 1/2
Bottomed in: Clay ☐ Sand ☐
Sandstone ☐ Shale X Coal ☐
Depth to top of bedrock 79
Total depth 188

⑩ CASING:
Type
Size of casing ... weight ... thickness 168
Weight 13
Bottom set at 31 ft.

⑪ SEAL: Yes ☐ No ☐
Packer ... Grout ... Driven X
Type ... Amount ...
Depth of seal 110' RUBBER SEAL

⑫ LINER: Yes X No ☐
Type PLASTIC (PVC, ABS)
Size O.D. 4 1/2 I.D. 4
Weight ... lbs.
Bottom set at 188 ft.
Perforated from 148 ft. to 187 ft.
How perforated Knife ☐
Machine X
Size perforations .050 in. by 6 mm

⑬ SCREEN: Yes ☐ No X
Make
Type
Size I.D. (clear)
Length
Slot size
Top at Bottom at
Fitting top
Fitting bottom

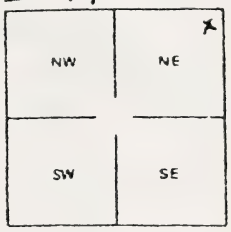
⑭ SAND PACK: Yes ☐ No X
Size Amount

⑮ PUMP: Yes ☐ No X
Type H.P.
Size Voltage
Drop pipe size Length
Installed at

⑭ LOCATION

¼	Sec.	Twp.	Rge.	West of Meridian
NE	2	14	28	4

Mark Well location with an "X" in diagram below
NE 2 - 14 - 28 - W 4



1 SQUARE MILE

⑰ WATER QUALITY:

Hard ☐ Medium Hard ☐
Soft ☐ Turbid ☐
Chemical Analysis: Yes ☐ 125 No X
Bacterial Analysis: Yes ☐ 3.M No X
76
42

⑱ WATER TEST:

Pump X AIR Bailer ☐
Static water level 84'
Rate of yield: 12-13 I.G.P.M.
Duration of test: 2 hrs. 30 min.
Pumping level or bailing level 160
Total drawdown:
Recommended pump setting: 145-150'
(Attach reading of any detailed pump tests)

Received Dec 22 1977 Environment

CERTIFICATION

⑲ WATER WELL DRILLER (operator)

This well was constructed under my direct supervision and all information given is true to the best of my knowledge and belief.
A copy of this report has been supplied to the owner.
Signature Peter Niemans
Date: Dec. 19 19 77

THIS REPORT TO BE SUBMITTED WITHIN 60 DAYS AFTER WELL COMPLETION, TO:
CONTROLLER OF WATER RESOURCES
ALBERTA ENVIRONMENT
MILNER BUILDING, EDMONTON

(12)

POLLUTION CONTROL DIVISION
LABORATORY
P.O. BOX 489
EDMONTON, ALBERTA
T5J 2K1

Alberta
ENVIRONMENT

Lab. No. 5957

CHEMICAL WATER ANALYSIS REQUEST

(For Water Intended For Human Consumption)

Routine Analysis ☑
F only ☐
NO_3+F only ☐
Other .....

Location of Sample: Mr. BERT NELSON (NAME) P.O Box 241 (ADDRESS) STAVELY (CITY, TOWN, VILLAGE) , ALTA (TELEPHONE)

☑ Private Supply
☐ Public Supply

Location NE ¼ Section 2 Township 14 Range 28 W 4 Meridian

Submitted by: ..... Phone .....
Fort Macleod Alberta T0L 0Z0
(ADDRESS) 3-1551

Results to: Health Unit ☑
Above ☐ or .....

Date Sampled: 3-6-80

Source of Sample: well - (HOME)
(NAME OF STREAM, DUGOUT, WELL, TAP, ETC.)

Well ☑ Depth 180 feet, Depth to Water Level ..... feet.

Well Completion Drilled
(DRILLED, DUG, SCREENED, ETC.)

Reason for Sample ☐ To Determine Suitability for Drinking Purposes

Other (Specify) .....

PC-1

Sampled by .....

CHEM. ANALYSIS REPORT

LOCATION : NELSON B. CH

LAB NO. 5957-W DATE REC D 06/06/80 DATE COMPLETED 12/ 6/80

PARAMETER	CODE	MG/L	PARAMETER	CODE	MG/L
PH	10301L	8.8	CONDUCTIVITY	02041L	1060.
IRON	26304L	0.02*	TDS	00205L	609.
CALCIUM	20105L	1.	MAGNESIUM	12303L	1.
HARDNESS T	10604L	8.	SODIUM	11103L	233.
POTASSIUM	19103L	0.8	SILICA	14102L	7.1
NO2 + NO3	07105L	0.05*	NITRITE	07205L	0.05*
FLUORIDE	09107L	4.67	CHLORIDE	17203L	33.
SULFATE	16306L	83.	BICARBONATE	06201L	490.
CARBONATE	06301L	15.	ALKALINITY T	10101L	426.

SUM OF CATIONS 10.30 SUM OF ANIONS 11.47

BALANCE 0.90

* INDICATES CONCENTRATION LESS THAN . CONDUCTIVITY REPORTED IN MICROSIEMENS/CM. PH IN PH UNITS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRITE AND NITRATE + NITRITE EXPRESSED AS N.

******* NOTE: NO VALUE
TDS - TOTAL DISSOLVED SOLIDS
NO2 = NITRITE
NO3 = NITRATE

CERTIFIED..... FOR
W.E. KORTSCH, HEAD, LABORATORY
POLLUTION CONTROL DIVISION
ALBERTA ENVIRONMENT

(13)

Alberta ENVIRONMENT
Earth Sciences and Licensing Division

WATER WELL DRILLERS REPORT

(1) WELL CONTRACTOR

ELGIN EXPLORATION
Address Co. LTD.
3504A - 72 Ave. S.E.
CALGARY

Date started Dec 19 76
Date completed Dec 19 76

TYPE OF WELL
Rotary [ ] Bored [ ] Cable tool [ ]
Jet [ ] Dug [ ] Other [ ]

TYPE OF WORK
New Well [X] Deepen [ ]
Reconditioned [ ] Abandon [ ]

PROPOSED USE:
Domestic [X] Stock [ ] Irrigation [ ]
Municipal [ ] Industrial [ ] Test [ ]

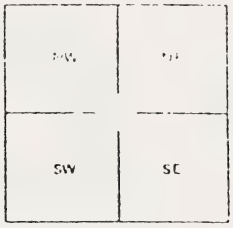
(2) WELL OWNER

ERIC NELSON
Address STRICTLY PITH.

(3) LOCATION

¼	Sec.	Twp.	Rge.	West of Meridian
NE	2	14	28	4

Mark Well location with an "X" in diagram below



1 SQUARE MILE

(4) FORMATION LOG DESCRIPTION

Depth - Feet From	To	Color, type of formation
		Hole #1
Ground Level		
0	85	CLAY + Rocks
85	200	SHALE + SANDSTONE
	RCD	
		P.C.P.M. coming in @ 130 FT.
		Hole # 2
0	35	CLAY + Rock
35	42	GRAVEL
42	85	CLAY + SAND
85	200	SHALE + SANDSTONE
		P.C.P.M. coming in @ 205 FT
		Hole Caved in

WELL COMPLETION DATA

DESIGN

Depth to top of perforations 195 FT - 205 FT
Total depth 200 FT

CASING:
Type
Size O.D. Wall thickness
Wt. per ft.
Bottom at ft.

SEAL: Yes [ ] No [ ]
Kind: Cement [ ] Grout [ ] Driven [ ]
Depth of seal

LINER: Yes [ ] No [ ]
Type
Size O.D. I.D.
Weight lbs.
Bottom set at ft.
Perforated from ft. to ft.
How perforated Knife [ ]
Torch [ ] Machine [ ]
Size perforations in. by in.

SCREEN: Yes [ ] No [ ]
Make
Material
Size I.D. (slot #)
Length
Slot size
Top at Bottom at
Fastened top
Fastened bottom

SAND PACK: Yes [ ] No [ ]
Size Amount

PUMP: Yes [ ] No [ ]
Type H.P.
Size Volume
Depth set Length

(5) WATER QUALITY:

Hard Medium Hard
Chemical Analysis Yes [ ] No [ ]
Bacteria Analysis Yes [ ] No [ ]

NOT REQUIRED

WATER TEST:

Pump [ ] Bailer [ ]
Static water level
Rate of yield 1/2 I. G. P. M.
Duration of test 2 hrs. — min.
Pumping level or bailing level 200
Total drawdown 200
Recommended pump setting —
Artesian reading (if any did not pump test)

Logging Verified
Alberta Environment

(6) CERTIFICATION

by
WATER WELL DRILLER (operator)

This well was constructed under my direct supervision and all information given is true to the best of my knowledge and belief.

A copy of this report has been supplied to the owner.

Signature
Date Dec 20 19 76

(7) ELECTRIC LOG:

Yes [ ] No [ ]
Gamma [ ] Electric [ ]

Jan/75

Map Sheet No. ... Co-ordinates ... Mer. 4 Tp. 14 R. 28 Sec. 3 ¼ or LSD ... Identification No. 3425
Altitude ...

FIELD OBSERVATIONS:
Type of observation ... Date ...
Comments:

Observed by:

WELL AND BOREHOLE DATA
Owner K Robinson Address Box 11, Stavely Date 1960
Driller ... Type of Rig ...
Completed Depth of Well 90'

Water-Bearing Intervals		Depth to Water	Well Construction		
From	to		(a) Slotted casing	From	to
From	to		(b) Open hole	From	to
From	to		(c) Screen	From	to
From	to		(d) Dug		
			(e) Bored		

Depth to water in Finished Well

AQUIFER TESTS
Test rate ... igpm Original available drawdown ...
Transmissivity { Apparent / Bail Test / Pump Test / Recovery / Equivalent } Q_∞, from pump test (estimated well yield) ...
Storage Coeff. at r_1 ... at r_2 ... at r_3 ...

CHEMISTRY 23.8.60 CHEM ANALYSIS

	ppm		%
Total solids	740	Mg	
Hardness	30	Ca	
Ca		Ca+Mg	4.4
Mg		Na+K	95.
Sulfates(SO_4)	187.2	Chlorides	1.4
Chlorides	6	CO_3+HCO_3	61.
CO_3+HCO_3		SO_4	32.
Alkalinity	405		
Nitrate (NO_3)	trace		
Iron	0.2		
Fluorine			

Soda = 27.8 gr/gl

LITHOLOGY STRAT.

Comments:
Water is chem. suitable
Soda will corrode alum.
& harm plants.

(15)

Alberta ENVIRONMENT
Earth Sciences and Licensing Division

WATER WELL DRILLERS REPORT

(1) WELL CONTRACTOR

FARM & RANCH DRLG
Address Box 1234
CLARESHOLM

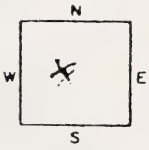
(11) WELL OWNER

FINE COULEE CATTLE CO LTD
Address Box 241
Stavely

(15) LOCATION

1/4	Sec	Twp	Rge	West of Meridian
NE	3	14	28	4

Mark well location with an "X" in diagram below



1 Quarter Section

(2) Date started May 14 19 75
Date completed 11 14 19 75

(3) TYPE OF WELL:
Rotary ☑ Bored ☐ Cable tool ☐
Jet ☐ Dug ☐ Hammer ☐

(4) TYPE OF WORK:
New well ☑ Deepen ☐
Recondition ☐ Abandon ☐

(5) PROPOSED USE:
Domestic ☐ Stock ☑ Irrigation ☐
Municipal ☐ Industrial ☐ Test ☐

WELL COMPLETION DATA

(6) DESIGN:
Open hole ☐ Slotted casing ☑
Screen ☐ Gravel pack ☐
Diameter of hole 5 1/2
Bottomed in: Clay ☐ Sand ☐
Sandstone ☐ Shale ☑ Coal ☐
Depth to top of bedrock 90
Total depth 90'

(10) CASING STEEL
Type
Size O.D 5 1/2 wall thickness: 156
Wt. per ft 8-5
Bottom set at 10 ft

(12) SEAL: Yes ☐ No ☐
Packer ☐ Grout ☑ Driven ☐
Loose ☐ Puddled clay ☐
Depth of seal

(13) LINER: Yes ☑ No ☐
Type PLASTIC
Size O.D 4 1/2 I.D 4
Weight lbs
Bottom set at 90 ft
Perforated from 70 ft. to 90 ft
How perforated Knife ☐ DRILLED
Torch ☐ Machine ☐
Size perforations: 1/4 in by 1/4 in

(14) SCREEN: Yes ☐ No ☐
Make:
Material:
Size I.D (clear)
Length
Slot size
Top at: Bottom at:
Fittings top
Fittings bottom

(16) SAND PACK: Yes ☐ No ☐
Size Amount

(17) PUMP: Yes ☐ No ☐
Type H.P.
Size Voltage
Drop pipe size Length
Intake at

(9) FORMATION LOG DESCRIPTION

Depth in Feet from	Depth in Feet to	Use key to formation
Ground Level	20	BRN CLAY & ROCK
20	21	SAND (WATER)
21	45	SFT BLE SH
45	46	SAND (DRY)
46	89	BLE SHA
98	90	SAND STN. (WATER)

(7) ELECTRIC LOG: Yes ☐ No ☐
Gamma ☐ Electric ☐

(18) WATER QUALITY:

Hard ☑ Medium hard ☐
Soft ☐ Turbid ☐
Chemical Analysis Yes ☐ No ☑
Bacterial Analysis Yes ☐ No ☑

(19) WATER TEST:

Pump ☐ Bailer ☑
Static water level 70'
Rate of yield 12 I.G.P.M
Duration of test 1/2 hrs min
Pumping level or bailing level 90
(Attach drawdown measurements, if taken)

CERTIFICATION

(8) WATER WELL DRILLER (operator)

This well was constructed under my direct supervision and the materials used and information given is true to the best of my knowledge and belief.

Signature Barry Culver
Date May 14 19 75

(20) WELL OWNER

I received copy of this report
Signature Bert A Nelson
Date May 14 19 75

THIS REPORT TO BE SUBMITTED WITHIN 30 DAYS AFTER WELL COMPLETION, TO:
WATER RIGHTS BRANCH
ALBERTA ENVIRONMENT
MILNER BUILDING, EDMONTON

WATER RIGHTS BRANCH

(10)

FIELD OBSERVATIONS:

Type of observation ..... Date .....

Comments: Test hole

Observed by: .....

WELL AND BOREHOLE DATA

Owner Dept of Agriculture B. Nelson Address Stavely Date 5/1968

Driller ..... Type of Rig .....

Completed Depth of Well 75'

Water-Bearing Intervals			Depth to Water
From		to	
From	14	to 26	
From		to	
From		to	

Well Construction

(a) Slotted casing	From		to	
(b) Open hole	From	0	to	10
(c) Screen	From		to	
(d) Dug				
(e) Bored				

Depth to water in Finished Well

AQUIFER TESTS

Test rate ..... igpm

Transmissivity { Apparent / Bail Test / Pump Test / Recovery / Equivalent

Original available drawdown .....

Q_{20}, from pump test ..... (estimated well yield)

Storage Coeff. ..... at r. .....

..... at r. .....

..... at r. .....

CHEMISTRY

	ppm		%
Total solids		Mg	
Hardness		Ca	
Ca		Ca+Mg	
Mg		Na+K	
Sulfates (SO_4)		Chlorides	
Chlorides		CO_3+HCO_3	
CO_3+HCO_3		SO_4	
Alkalinity			
Nitrate (NO_3)			
Iron			
Fluorine			

Comments:

LITHOLOGY

0-5	sdy loam
5-14	clay sd (wtr)
14-17	sdy clay (wtr)
17-19	ss
19-75	hd sh, ss stringers

STRAT.

Map Sheet No. 82-1 Co-ordinates 82-I/4 E Contents drilled LITHOLOG

Mer. 4 Tp. 14 R. 28 Sec. 11 ¼ or LSD 6 Altitude 3450' Identification No.

(17)

FIELD OBSERVATIONS:

Type of observation Date

Comments:

Observed by:

WELL AND BOREHOLE DATA

Owner Address Date

Driller Type of Rig

Completed Depth of Well

Water-Bearing Intervals		Depth to Water	Well Construction		
From	to		(a) Slotted casing	From	to
From	to		(b) Open hole	From	to
From	to		(c) Screen	From	to
From	to		(d) Dug		
			(e) Bored		

Depth to water in Finished Well Water Temp F C

AQUIFER TESTS

Type	Transmissivity	Q	Test rate	gpm for	min
Pump Test			Total Drawdown		
Bail Test			Original available drawdown		
Recovery Test			Storage Coeff.	at r.	
Apparent-Yield Test				at r.	
				at r	

CHEMISTRY	ppm	epm	%	LITHOLOGY
Calcium				
Magnesium				
Sodium				
Potassium				
Iron				
Nitrate (NO_3)				
Chloride				
Sulfate (SO_4)				
Fluoride				
Carbonate (CO_3)				
Bicarbonate (HCO_3)				
Silica (H_4SiO_4)				
Hardness (as $CaCO_3$)				
Alkalinity (as $CaCO_3$)				

	ppm	epm
Total Solids		
Conduct. at 25° C	lab	field
pH	lab	field
Cation: Anion Balance		%
Total Solids Balance		%

Comments:

Identification No. 16 Altitude

Mer. 4 Tp. 14 R. 28 Sec. 11 ¼ or LSD

Coordinates 45'S 0'E NEC'D

Map Sheet No. 83L Contents FLOWING SHOT HOLE

MERIDIAN | TOWNSHIP | RANGE | SECTION

WATER SAMPLES | SUITABLE HUMAN | TOTAL SOLIDS (P.P.M.) | IGN. LOSS | HARDNESS | SULFATES | CHLORIDES | ALKALINITY | NITRITES | NITRATES | IRON | FLUORIDES | SODA | GLAUBER'S SALTS | LIME | MAGNESIA | SUITABLE STOCK

WATER QUALITY

DATE _____ CO ORDS _____ L.S.D. _____ SEC 11 TP. 14 R. 28 W. of 4 M.

SITE F.S.H. DRILLER _____ ADDRESS _____

CITY TOWN _____

ALTITUDE: EST. SURV _____ DEPTH OF WELL REPT. MEAS 120 DEPTH TO WATER REPT. MEAS flowing (five) DIAM _____

CASING LENGTH _____ DIAM _____ TYPE _____ FINISH A _____ B _____

C SCREEN _____ GRAVEL PACK DETAILS _____

AQUIFERS NAME _____ THICKNESSES _____ WATER AT _____

OTHER _____

FLOW _____ G.P.M. _____ LBS OF PRESSURE _____ HT. ABOVE G.L. _____ SINCE _____

PUMP: TYPE _____ H.P. _____ PUMPING RATE _____

TEST _____ RATE _____ G.P.M.

DRAWDOWN _____ FT. AFTER _____ DAYS _____ HRS

RECOVERY _____ FT. IN _____ MINS / HRS

SPEC. CAP _____ TRANS _____ STOR. COEFF _____ POROSITY _____ %

DISCHARGE _____ CORE PERM _____ OTHER _____

MECH. ANAL. YES / NO _____ SIZE _____ M.M.S / INS UNIF. COEFF _____ GR. PACK RATIO _____

USE _____ WATER SAMPLE _____ DATE OF _____

QUAL. OF WATER: TURBIDITY _____ ODOR _____ PRESENCE OF GAS _____ OIL _____ OTHER _____

SEISMIC SHOT HOLE OIL CO _____ E-LOGS OIL CO _____

SEISMIC DATA G.W. _____ RESISTIVITY DATA G.W. _____ E-LOGS G.W. _____

REMARKS Owner Imperial Oil

0 - 25' Clay & Gravel.
25 - 95' Blue clay & Boulders.
95 - 120' Shale

GROUNDWATER REPORTS: REC. 13 64
PUB. 12

TYPE: DUG / BORED B / DRILLED / DRIVEN / OTHER

DEPTH: 0 - 50 FT. / 51 - 100 FT. / 101 - 200 FT. / 201 - 300 FT. / 301 - 500 FT. / 501 - 750 FT. / 751 - 1,000 FT. / 1,001 + FT.

USE: DOM. / STOCK / PUBLIC / IND. / IRRIG. / OBSERV.

LOGS: DRILLER'S / E-LOGS / SEISMIC / R.C.A.T.H. / LITH. SAMPLES

YIELD: 0 - 5 G.P.M. / 5.1 - 25 G.P.M. / 25.1 - 125 G.P.M. / 125.1 + G.P.M.

AQUIFERS: SILT, CLAY / SANDSTONE / COAL / TILL / BURIED GRAVEL / OUTWASH S. & GR.

HYDRAULIC TYPE: WATER TABLE / ARTESIAN NON-FLOW / ARTESIAN FLOW / PARTIALLY CONFINED / OTHER

FORMATIONS

USE MASTER CODE LIST FOR IDENTIFICATION

(11)

LITHOLOGIC LOGS R C A ETC.	E-LOGS	PUMP DETAILS
0'-25' CLAY & GRAVEL		
25'-95' BLUE CLAY & BOULDERS		
95'-120' SHALE		
		OTHER

(18)

DEPARTMENT
OF THE ENVIRONMENT

DIVISION OF POLLUTION CONTROL
LABORATORY
10302 - 107 STREET,
EDMONTON 14, ALBERTA

CHEMICAL WATER ANALYSIS REPORT

Lab. No. 71 - x 3213

Date Rec'd APR 12/71

Date Analyzed APR 13/71

*Routine Analysis [X]
F only [ ]
NO_3 only [ ]
Na only [ ]
Other [ ]

I. History

Location of Sample:

a) Urban Stanford (NAME) Stavely (STREET) (CITY, TOWN, VILLAGE)

b) Rural (NAME) (ADDRESS) (TELEPHONE)

Location SE ¼ Section 24 Township 21 Range 28 W 4 Meridian

Submitted by: [illegible] Phone 276-2206

[illegible] (ADDRESS)

Results to: Above [X] or [illegible]

Date of Sample: APR 5/71

Source of Sample: well (NAME OF STREAM, DUGOUT, WELL, TAP, ETC.)

a) Urban Supply [ ] b) Well [X] Depth 100 feet, Depth to Water Level 20 feet.

Well Completion drilled (DRILLED, DUG, SCREEN, SETTLING ETC.)

Reason for Sample: [illegible]

Sampled by

II. Analysis

Specific Conductance 2100 µmhos/cm *Indicated Total Dissolved Solids 1590 mg/l

pH 6.3 *Hardness, Total 120 mg/l $CaCO_3$ S.A.R.

Cations	me/l	mg/l		Anions	me/l	mg/l	
*Calcium		26	Ca	*Alkalinity, pp.			$CaCO_3$
*Magnesium		31	Mg	Total		230	$CaCO_3$
*Sodium		430	Na	*Sulphate		925	SO_4
Iron	less than	0.2	Fe	*Chloride		36	Cl
Potassium			K	Nitrite Nitrogen		<0.1	N
				*Nitrate Nitrogen			N
				Fluoride		0.75	F

Balance

Comments For interpretation of the results, PLEASE CONTACT your local Medical Officer of Health.

W. E. [illegible], Head, Division of Pollution

(18

POLLUTION CONTROL DIVISION
LABORATORY
P O BOX 430
EDMONTON, ALBERTA
T5J 2K1

Alberta
ENVIRONMENT

Lab. No 2157

CHEMICAL WATER ANALYSIS REQUEST

(For Water Intended For Human Consumption)

Routine Analysis ☑
F only ☐
NO_3+F only ☐
Other .....

Location of Sample G. Stanford Clyde Sec 14 (NAME) (ADDRESS) (CITY, TOWN, VILLAGE)

228-2116 (TELEPHONE)

☑ Private Supply
☐ Public Supply

Location SW ¼ Section 14 Township 14 Range 28 W 4 Meridian

Submitted by Church South Wgl Phone 284-4451
CO 227 Fortyhead (ADDRESS)

Result with Unit ☑
e ☐ or

Date Sampled: Mon 6/73

Source of Sample: (NAME OF STREAM, DUGOUT, WELL, TAP, ETC.)

Well ☑ Depth [illegible] feet, Depth to Water Level 50 feet.

Well Completion Drilled (DRILLED, DUG, SCREENED, ETC.)

Reason for Sample: ☑ To Determine Suitability for Drinking Purposes

Other (Specify) .....

PC 1

Sampled by G Stanford

CHEM. ANALYSIS REPORT

LOCATION : STANFORD G. CHIN

LAB NO. 2157-W DATE REC'D 06/03/73 DATE COMPLETED 06/ 3/73

PARAMETER	CODE	MG/L	PARAMETER	CODE	MG/L
PH	10301L	6.0	CONDUCTIVITY	02041L	2540.
IRON	26302L	0.12	TDS	00205L	1643.
CALCIUM	20105L	23.	MAGNESIUM	12303L	7.
HARDNESS T	10604L	85.	SODIUM	11103L	530.
POTASSIUM	19103L	2.3	SILICA	14102L	7.6
NO2 + NO3	07105L	0.1*	NITRITE	07205L	0.1*
FLUORIDE	09107L	0.04	CHLORIDE	17203L	34.
SULFATE	16306L	915.	BICARBONATE	06201L	270.
ALKALINITY T	10101L	222.			

SUM OF CATIONS 24.80 SUM OF ANIONS [illegible]

BALANCE 1.01

* INDICATES CONCENTRATION LESS THAN . CONDUCTIVITY REPORTED IN MICROSIEMENS/CM. PH IN PH UNITS. ALKALINITY AND HARDNESS EXPRESSED AS CALCIUM CARBONATE. NITRITE AND NITRATE + NITRITE EXPRESSED AS N.

TDS = TOTAL DISSOLVED SOLIDS
NO2 = NITRITE
NO3 = NITRATE

CERTIFIED [illegible] (LW)
W.E. KRITSCH, HEAD, LABORATORY
POLLUTION CONTROL DIVISION

Map Sheet No. 52 I Co-ordinates Contents CHEM ANALYSIS Mer. 4 Tp. 14 R. 29 Sec. ___ ¼ or LSD Identification No. Altitude

FIELD OBSERVATIONS:

Type of observation Date

Comments:

Observed by:

WELL AND BOREHOLE DATA

Owner Mrs. H. K. Hendricks Address RR # 2 Medicine Hat Date drilled

Driller Type of Rig

Completed Depth of Well 140'

Water-Bearing Intervals	Depth to Water	Well Construction	
From to		(a) Slotted casing	From to
From to		(b) Open hole	From to
From to		(c) Screen	From to
From to		(d) Dug	
		(e) Bored	

Depth to water in Finished Well 7'

AQUIFER TESTS

Test rate igpm Original available drawdown

Transmissivity { Apparent; Bail Test; Pump Test; Recovery; Equivalent }

Q_w, from pump test (estimated well yield)

Storage Coeff. at r_1

at r_2

at r_3

CHEMISTRY April 25, 1972

	ppm		%
Total solids	975	Mg	14
Hardness	256	Ca	23
Ca	64	Ca+Mg	37
Mg	23	Na+K	63
Sulfates(SO_4)	240	Chlorides	1
Chlorides	7	CO_3+HCO_3	62
CO_3+HCO_3		SO_4	34
Alkalinity	406		
Nitrate (NO_3)	0.45		
Iron	0.2		
Fluorine	1.17		

LITHOLOGY STRAT.

Comments:

(20

FIELD OBSERVATIONS:

Type of observation — Date

Comments:

Observed by:

WELL AND BOREHOLE DATA

Owner K. Rusk — Address Stanley — Date drilled

Driller — Type of Rig

Completed Depth of Well 145

Water-Bearing Interval		Depth to Water	Well Construction		
From	to		(a) Slotted casing	From	to
From	to		(b) Open hole	From	to
From	to		(c) Screen	From	to
From	to		(d) Dug		
			(e) Bored		

Depth to water in Finished Well 70 — Water Temp F C

AQUIFER TESTS

Type	Transmissivity	Q	Test rate	gpm for	min.
Pump Test			Total Drawdown		
Bail Test			Original available drawdown		
Recovery Test			Storage Coeff.		at ft
Apparent-Yield Test					at ft
					at ft

CHEMISTRY (mg/l)	ppm	epm	LITHOLOGY
Calcium	<1	-	
Magnesium	<1	-	
Sodium	238	100	
Potassium	.7	.2	
Iron	.3	-	
Nitrate NO	0.45	-	
Chloride	16	4	
Sulfate SO	62	13	
Fluoride	0.22	-	
Carbonate CO	37	12	
Bicarbonate HCO	444	71	
Silica H SiO			
Hardness as CaCO	5		
Alkalinity as CaCO	425		

Total Solids	ppm	975	epm
Conductance at 25° C	lab	920	field
pH	lab	8.7	field
Cation-Anion Balance			1.1
Total Solids Balance			1.00

Comments:

Map Sheet No. — Coordinates — Sec. 27 — Tp. 17 — R. 28 — ¼ or LSD SE — Identification No. — Altitude 3495'

CHEM ANALYSIS — Contents

(21)

FIELD OBSERVATIONS:

Type of observation ..... Date .....

Comments:

Observed by: .....

WELL AND BOREHOLE DATA

Owner R. Scott Address Grady Date drilled

Driller ..... Type of Rig .....

Completed Depth of Well 120

Water-Bearing Intervals		Depth to Water	Well Construction		
From	to		(a) Slotted casing	From	to
From	to		(b) Open hole	From	to
From	to		(c) Screen	From	to
From	to		(d) Liner		
			(e) Bailed		

Depth to water in Finished Well 30 Water Temp. F C

AQUIFER TESTS

Type	Transmissivity	Test rate gpm. for min.
Pump Test		Total Drawdown
Bail Test		Original available drawdown
Recovery Test		Storage Coeff. at r_1
Apparent Yield Test		at r_2
		at r_3

CHEMISTRY 4-25

	ppm	epm %
Calcium	16	6
Magnesium	21	-
Sodium	269	93
Potassium	7	1
Iron	.2	-
Nitrate (NO_3)	2.45	-
Chloride	9	3
Sulfate (SO_4)	170	57
Fluoride	2.90	-
Carbonate (CO_3)	36	12
Bicarbonate (HCO_3)	442	89
Nitrate (NO_3)		
Hardness (as $CaCO_3$)	95	
Alkalinity (as $CaCO_3$)	424	

LITHOLOGY

Total Solids	ppm	730	epm
Spec. at 25°C	lab	1150	field
pH	lab	8.9	field
Cation-Anion Balance			%
Total Solids Balance			%

Comments:

CHEM ANALYSIS

FIELD OBSERVATIONS:

Type of observation ..... Date .....

Comments: .....

Observed by: .....

WELL AND BOREHOLE DATA

Owner [illegible] RAY Address [illegible] SAGE, R R 3 HIGH RIVER Date .....

Driller ..... Type of Rig drilled

Completed Depth of Well 130'

Water-Bearing Intervals		Depth to Water	Construction		
From	to		(a) [illegible]	From	to
From	to		(b) [illegible]	From	to
From	to		(c) [illegible]	From	to
From	to		(d) [illegible]		
			(e) Bored		

Depth to wat[illegible] Finished Well 40'

AQUIFER T[illegible]

Test [illegible] igpm (Observed) Available drawdown .....

Transmissivity { Apparent / Bail Test / Pump Test / Recovery / Equivalent }

Q[illegible] from pump test .....
(estimated well yield)

Storage Coeff. ..... at r. .....
..... at r. .....
..... at r. .....

CHEMISTRY 6/3/72

	ppm		%
Total solids	850	Mg	9
Hardness	265	Ca	15
Cl	66	Ca+Mg	24
[illegible]	5	Na+K	76
Sulfates (SO_4)	650	Chlorides	1
Chlorides	6	CO_3+HCO_3	24
CO_3+HCO_3		SO_4	61
Alkalinity	420		
Nitrate (NO_3)	2.45		
Iron	0.3		
Fluorine	.7		

Comments: .....

LITHOLOGY

STRAT.

N.L.C. - B.N.C.
3 3286 07370474 0